Towards a Science and Technology Policy for a Democratic South Africa

Mission Report
July 1993

IDRC
CANADA

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Foreword

This volume represented the third publication of a series of Mission Reports sponsored by the International Development Research Centre (IDRC) in South Africa. As part of the IDRC's policy towards South Africa, the Centre has supported these initiatives to assist the Democratic Movement to participate in negotiations with the current government and to prepare for a future role in a democratic South Africa.

This Mission Report, "Towards a Science and Technology Policy for a Democratic South Africa", represents a departure from the previous IDRC Missions in the areas of economic and urban policy. These earlier activities were jointly undertaken by the IDRC and the Democratic Movement, where representatives from both sides played a role in all parts of the process. In the case of this mission, the initiative was shaped along the line of an OECD style external examination of the science and technology system of South Africa. In following the OECD methodology, the mission members alone are responsible for the content of the Report.

The IDRC welcomed the invitation from the ANC, COSATU, and SANCO to provide assistance for this exciting project.

Marc Van Ameringen
Regional Director
IDRC Regional Office for Southern Africa
Johannesburg, South Africa

Mr Nelson Mandela,
President,
The African National Congress.

Mr Jay Naidoo,
Secretary General,
The Congress of South African Trade Unions

Mr Moses Mayekiso
President,
South African National Civics Organisation.

Ottawa, March 31, 1993

Gentlemen,

With this letter, I wish to transmit to you, and to the Democratic Movement, the final and complete report of the activities of the Science and Technology Policy Mission which was commissioned by the ANC, COSATU and SANCO and supported by the International Development Research Centre. This volume contains:

- a final version of the report, prepared by the mission, following our two-week visit to South Africa last November;
- an account of two public meetings held in Johannesburg in early March, the first with representatives of the Democratic Movement, the second with officials from government, the universities and the organisations which represent the private sector; and
- a copy of the set of "Issues for Discussion" which constituted a basic agenda for the two public meetings and which we, the members of the Mission, feel will be helpful in providing a basic framework for further public debate, within South Africa, on future directions for your national S&T Policy.

Any brief review of activities in a country as complex as the South Africa of today is bound to seem superficial. We are only too aware of the limitations of what can be learned during a two-week mission. Some of the issues we identified clearly require further analysis and debate before policy conclusions can be drawn. There are other issues which we would have wished to examine, had we had more time, or been able to access the

information which would have enabled us to comment meaningfully. We believe it is important for future debate to be even more expansive than the one we have set in motion. Here we sketch briefly some of the additional topics which, we feel, are important.

A first obvious topic, which is touched on only briefly in our report, is that of the possible conversion to purely commercial purposes of the technological capacities built up by South Africa in support of its Military and Nuclear Energy Programmes. We have no clear information on the scale of the technological potential involved, although it is widely assumed to be an important fraction of South Africa's overall capacity. Nor have we been able to explore the efficiency of the links between the research capacities in these fields and commercial production capacities. Some evidence, from countries such as the US, suggests that military contractors who have been supported by government as a matter of policy, find it difficult to make the transition to operating in a highly competitive marketplace.

During discussions of our report, it became obvious that many people would have welcomed a more extensive and prominent discussion of the role of the social sciences, and the institutions supporting the social sciences, in a democratic South Africa. The members of the Mission believe that it is important for all countries to support the social sciences, as they play at least three roles necessary to a democratic state. The social sciences have important roles to play:

- in informing and improving the processes of developing public policies by all levels of government;
- in working with the natural and engineering sciences to help articulate the needs of the population, providing guidance to those who would stimulate technological change as a means of attaining social and economic goals; and
- in providing informed and carefully argued critiques of societal trends and the public policies which shape or interact with these trends; such contributions can be significant in establishing traditions of free political discourse in a democratic society.

Some of these roles can be performed within state institutions, others are more comfortably carried out within a university or other non-governmental environment. However, government needs to support a carefully designed system to allocate resources to all of these activities, no matter where they are located institutionally.

Given time, we would have welcomed an opportunity to deal at greater length with questions of innovation policy, of the role of small and medium scale enterprises, and of the actual records of existing enterprises in South Africa in the promotion of technological change. This set of issues could well be pursued by the National Economic Forum.

Our visits to South Africa did not clarify how governmental authority would be allocated among various possible levels of government in any final constitution. As a result we did not discuss the roles and responsibilities, in science and technology, of levels of government other than the central government. We do wish to emphasise, however, that all levels of government - central, state/provincial and municipal - should look to science and technology as one route to tackling the many problems each of them will face.

We would be remiss if we did not note how rapidly events are moving in South Africa and how much opening for discussion has been created in the brief months from the beginning of our exercise to the present. The open dialogue between representatives of the Democratic Movement and government officials dealing with science and technology which took place as we were completing our stay in South Africa, would have been hard to imagine a few months earlier as we began our work. These trends are encouraging and we hope that much public debate will follow - debate around the capacity of the country to address its social and economic goals for the future.

We have been struck by the extensive capability of South Africa's science and technology system, which is by far the largest in Africa south of the Sahara. It constitutes a major asset which a new government will need both to nurture and to mobilise, to tackle the many economic and social problems which will face a democratic South Africa.

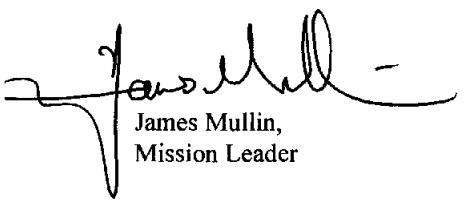
To draw this letter to a close, we would simply repeat two of the ten "overall impressions" with which we introduced the main findings of our report. We believe, as we wrote in the main report, that

> *deep-seated prejudices and intense resentment at past injustices will pose considerable impediments in the way towards the creation of a new South Africa; the S&T community, which has been privileged to receive very advanced levels of education, should be in the forefront of South African society in overcoming these obstacles and in working for the common good,*
> and

as an example to all South Africans of how political life in this country can be transformed, we would call on all members of the S&T community to become active participants in the public debate on the future directions of S&T Policy for this potentially prosperous home for all South Africans.

Finally, we wish to thank the Democratic Movement for giving us the opportunity to gain this "glimpse" of South African science in transition. We would also like to thank all those who responded to our many questions with courtesy, frankness and with enthusiasm.

Yours sincerely,



James Mullin,
Mission Leader

A Report to the ANC, COSATU and SANCO

by a Mission sponsored by
The International Development Research Centre
(Canada).

January, 1993

Introduction

The Context

The review of South African Science and Technology Policy covered in this report was carried out during a period when that country was in the early stages of a fundamental political transition. It had committed itself to a process of transformation by abandoning its strategy of "Grand Apartheid" which had made it an international pariah, the object of extensive international sanctions, and which had consciously marginalised the vast majority of its population by systematically denying them the political, social, economic and cultural rights and freedoms which are the basis of any truly democratic state. However, having abandoned the past, constructing a new future has not been easy. At the time of writing, formal negotiations around the creation of an interim government and drafting and implementing a new democratic constitution were still officially stalled. The climate of violence pervading the society showed no signs of diminishing, and, the global economic recession was seriously affecting the South African economy.

In trying to understand South Africa's institutions, it is necessary to see them as products of the Apartheid system. Where else, but in South Africa, could one find a state that had created fifteen parallel Departments of Education, fifteen Departments of Health, and fourteen Departments of Agriculture, under the guise of giving different groups responsibility for their "own affairs", while systematically depriving all but one of the racial groups of adequate resources to manage those affairs?

In a letter requesting that this review be undertaken, the ANC, through its Research Department, argued that:

> *the institutions [of the state engaged in the research system], their policies and agendas, their employment and training practices, and even their attempts at adaptation to political change, have been shaped by years of service to a society structured on Apartheid lines. Scientific research and technological development were subordinated to the ideology of "total strategy", fashioned in order to mobilise the country's resources in defence of white minority rule. Social investigation was dominated by apartheid notions and in particular with the management of 'group relations'. Military requirements set the agenda for technological development.*

During the mid-1980's, these institutions, recognising that the existing political and social order had only a very limited future, embarked on various programmes of restructuring. Those in control did this without consultation. Conceived within the framework of the old order, these processes excluded the major social and political actors from the determination of the programmes of change. They have therefore failed to confront the fundamental issues relating to the transformation of the national research system into one which will serve the needs of a democratic society.

The legacy of Apartheid, as seen by members of the Democratic Movement, has led to the evolution of a research system whose principal characteristics are:

- an orientation towards the needs of the white minority;
- an emphasis on technological development to serve the needs of state security, and the suppression of the majority of the population, as evidenced by the high share of resources allocated to defence and the nuclear programme;
- an imposition of secrecy as an imperative value in the workings of government, and the stifling of debate, even among the white population, on major issues of public policy;
- an approach to technological development - dominated for many years by domestic protectionism and external economic sanctions - which allowed policy choices and resource allocations to be based on criteria related to the presumed interests of state security rather than economic efficiency or social equity; and
- a rationalisation, within the scientific community, that scientific and technological developments were, in some sense, apolitical, hence absolving this community of any responsibility for the policies which their activities served.

During our visits, and after lengthy discussion with senior officials, we certainly saw evidence of attitudes and practices which reflect these far-reaching criticisms. There was an assumption, usually implicit, that the science and technology system should continue to serve the needs of "First World" South Africa, while making only token gestures to the "Third World" reality of the vast majority of the country's population.

But we have seen more than that. We have seen people trying to understand the realities of the past and trying, to the limits of their abilities -

and more importantly, to the limits of their experience - to adjust to the new reality of working, as one official put it - "in a scientific institution in a large, African, developing country, not in an industrialised country with a large poor minority." And, of particular importance, we have seen evidence that many of the institutions reviewed are struggling to find ways to meet the challenges of the globalisation of technological development - a process from which the international community has sought to exclude South Africa until it returns to an acceptable form of democratic behaviour - and the challenges of a global economic recession.

Our observations, therefore, have enabled us to evaluate and comment on the changes being implemented by many institutions as changes brought about as a result of the confluence of three sets of forces:

- those created by the pressures for real political change within the country;
- those demanding a response to the rapid globalisation of the processes of technological development which no country, including a democratic South Africa, can afford to ignore; and
- those imposed upon the S&T system by the effects of a global economic recession, which has restricted the capacities of all governments to provide resources for many activities, including those relating to science and technology, and ultimately, to the future prospects of prosperity for all countries.

As if these challenges were not enough, we have found that individual institutions trying to adapt are doing so in a policy vacuum at the highest levels of the present South African government. It may be that in the past, during the days of the National Party government's "Total Strategy", there was strong coordination and shared purpose among the institutions of the white-dominated state. If that was the case then, we found no evidence of it being the case today. Rather, we saw a series of institutions, each trying to define for itself a role in a "new" South Africa - for many of them a concept they were only beginning to understand.

We have chosen to present our report in two parts; Part One sets the scene by discussing the mechanics of our study, including its specific terms of reference, and then provides a resume of some important international documents. These documents, we believe, could usefully inform public debate on directions for Science and Technology Policy in South Africa. Part Two contains our findings.

PART ONE:
Background Considerations

The Origins and Conduct of the Review

The Origins of this Report

The origins of this report on S&T policy options for a fully democratic South Africa are to be found in discussions, among researchers related to the Mass Democratic Movement, which followed the January 1992 symposium on *"The Role of Research in Transforming South Africa"* co-sponsored by the Journal *Transformation* and the International Development Research Centre.

One striking feature of the vigorous debates at that symposium was an absence of discussion of possible directions for Research Policy in a future South Africa. Out of this observation came discussion among the ANC, COSATU, SANCO and the IDRC on what steps might be taken to make Research Policy, or more broadly, Science and Technology Policy (S&T Policy) - including the roles and needs of Social Science Research - the subject of national debate. These exchanges led to an agreement that a useful first step in promoting wide debate on national S&T Policy would be to conduct a review of existing S&T Policy in South Africa and of the institutions involved. It was also proposed that the investigation followed the process developed and tested by the Organisation for Economic Cooperation and Development (OECD) for use in the industrialised world.

The Concept of Science and Technology Policy

It is important to set out clearly the wide-ranging area of activities covered by S&T Policy as this phrase is now understood; it encompasses many activities that would not be covered by the concept of "Research Policy".

Briefly put, S&T Policy is concerned with the generation, acquisition and application of knowledge from all of the sciences (social as well as natural) by countries in pursuit of their own economic, social and cultural development. It encompasses all aspects of the support of research. Equally importantly, it deals with educational processes which produce the participants in scientific and technological activities. S&T Policy is vitally concerned with the links which must exist between research and those institutions - public and private - which make use of the knowledge and technologies emerging from the global S&T system. Those institutions, in turn, play their respective roles in the national economy and in the national effort to achieve social and cultural development. S&T Policy also involves the various activities of public and private bodies to design and stimulate

technical change and innovation, not all of which are directly linked to research.

The Methodology Adopted by the Review

As a result of discussions among representatives of the ANC, COSATU, SANCO and the IDRC, it was agreed to use the methodology developed for the review of S&T Policy in the industrialised countries (OECD). This was seen as a first step in promoting wider, public debate within South Africa on S&T Policy. (Invitations to participate were sent to the key institutions in South Africa's S&T system - in government, in the universities, in the private sector and among the groups affiliated to the Democratic Movement. Almost all institutions invited welcomed the activity and participated actively.)

The *first of the three stages* of an OECD-style review involves the preparation of background documentation on existing S&T Policy in the country to be reviewed. A list of the existing institutions implementing these policies is drawn up, together with a preliminary commentary on how those institutions are meeting the goals and objectives in their existing mandates.

This phase of the activity was pursued in the period between early September and late October 1992, during which time extensive documentation was accumulated from a variety of state institutions. A number of essays, on the current functioning of the South African S&T system, were written by independent researchers. Extensive additional material was collected during the second phase and it is hoped that a companion volume to this report will be published, in order to make all this useful information publicly available.

The *second phase* of an OECD review involves appointing a group of people, from outside the country under review, who are experienced in the areas of S&T Policy, research management, and the conduct of scientific and technological activities more generally. These individuals visit the country under review for an extensive set of interviews with those responsible for the management and direction of key institutions. This phase was carried out from the 15th to the 28th of November. The foreign members of the Mission are listed in Appendix 1, the South Africans who assisted the Mission are listed in Appendix 2, and the schedule of meetings followed is set out in Appendix 3. The present report sets out the observations and conclusions of the international members of the Mission - they are fully responsible for its contents.

The *third phase* of the activity involves a series of meetings between the Mission and the sponsors of the review with those who were interviewed, to allow for a full exploration of the observations, conclusions and questions raised by the Mission.

Specific Terms of Reference

As finally adopted, the specific terms-of-reference of the review called on it:

1. To describe:
   - the prevailing organisation of the research system in South Africa, in both the natural and social sciences, and in both the public and private sectors;
   - the existing arrangements for the formulation of S&T Policy within the government of South Africa;
   - the present links between the research system and social, economic or policy organisations which are expected to use the research outputs;
   - the present arrangements for training researchers;
   - the existing links between the South African research system and other such systems in both the industrialised and the developing world, including questions related to access to S&T information; and
   - the current system for financing research, and the priorities pursued by that financing.
2. To review and assess the present performance of the system, as described, against the goals currently identified for the system.
3. To assess broadly the extent to which the present research system meets the needs of the disadvantaged majority of the population, and to indicate where changes - in policy direction, structure, or financing - will be needed in the future, in order to address those needs.
4. To propose the main elements of initial S&T Policy and organisation to meet the needs of a post-Apartheid South Africa, taking into account both the domestic and international contexts within which implementation will have to take place.

Competitiveness, Equity and Sustainability:

The International Agenda for S&T Policy

Throughout the world, countries are grappling with three broad sets of policy objectives: those of promoting international competitiveness for their enterprises; social equity for all members of their societies; and sustainability of their interactions with the natural environment. Though progress may be painfully slow, there is a growing consensus, at the level of policy agendas, that these three goals are inseparable - no country can afford to emphasise only the economic goal of competitiveness and rely on "trickle down" effects to provide for the attainment of the other two.

During 1992, these topics were the subject of three landmark documents emerging from three different fora. The Economic Commission for Latin America and the Caribbean, (ECLAC), published its proposals on *"Social Equity and Changing Production Patterns: an Integrated Approach"* in January (ECLAC Document No LC/L.668), the Organisation for Economic Cooperation and Development (OECD) published its major review of *"Technology and the Economy: the Key Relationships"* soon after that, and in June, a global consensus was reached, at the United Nations Conference on Environment and Development in Rio de Janeiro, on "Agenda 21", a blueprint for sustainable development.

As South Africa grapples with the complex task of debating, and ultimately defining, a Science and Technology Policy for a future democratic government, it would do well to consider the thinking which has emerged from both North and South on these crucial issues. These ideas could provide the guidance necessary to begin the process of ensuring the full participation of all South Africans in the economic, political, social and cultural life of the country in the years ahead.

The ECLAC report summarises its proposed policy thrust in these words:

> *...[E]nvironmentally sustainable growth with equity, in a democracy, is not only desirable but possible. Indeed, just as social equity cannot be attained in the absence of strong, sustained growth, such growth likewise calls for a reasonable degree of social and political stability, and this in turn means meeting certain minimum requisites of equity. It is clear from this interdependence between growth and equity that it is*

> ***necessary to advance towards these two objectives simultaneously rather than sequentially,*** *[emphasis in the original] and this represents an unprecedented challenge.*
> *...it is understood that equity will improve through advances in the attainment of at least one of the following three objectives. The first of these is to minimise the proportion of persons and households whose living conditions are below those which society considers acceptable, not only economically but also socially and politically. The second is to promote the development of the latent skills existing in all groups of society, progressively doing away with legally established privileges and forms of discrimination, as well as any other forms of inequality of opportunity, including those associated with social, ethnic or geographical origin or gender. The third is to do everything possible to ensure that neither power, wealth, nor the fruits of progress are concentrated in such a manner as to restrict the freedom of present or future generations, harming the environment in which they must live and develop.*[1]

The three central elements of ECLAC's integrated policy approach revolved around Technical Progress, Productive Employment and Investment in Human Resources. Later we look at some directions which South Africa might follow to define for itself suitable policy options in these areas.

The theme of "policy integration" adopted by ECLAC is echoed strongly in the OECD's work. This goes beyond policy integration, to focus on essential new forms of integrated activity among economic actors within any economy which hopes to become, and remain, competitive.

Recent work in the industrialised countries has highlighted the importance of "networks of innovators". There are many different kinds of network arrangements, both formal and informal, now in frequent use by the enterprises of the industrialised world. These enhance their innovative - and hence competitive performance. As is to be expected, such arrangements are particularly prevalent in the new, "high technology" areas of biotechnology, information technologies and new materials.

Government policies are attempting to support these cooperative ventures, recognising the complex and multidisciplinary nature of many of the advanced projects now being undertaken. It can be argued that, in fact, individual companies' recognition of the need to supplement their own in-house expertise, with expertise from other fields, has fostered their participation in such arrangements.

As governments of the industrialised countries act to promote the competitiveness of their economies, they see the need to create or enhance a climate for innovation. Making companies and institutions of any country more innovative requires attention to a long list of policy items. In a typical industrialised country today, such a listing[2] would include:

- ..broad *framework policies* favourable to innovation. These include: the regulatory environment; creating conditions favourable to young, innovative firms; policies that would make the country involved a more attractive location for R&D; and so forth;
- ..a battery of *human resources policies* that will inspire more young people to pursue technical careers and that will provide much more extensive employee training; and
- at the level of the individual firm, policies to promote development, *acquisition and diffusion of technology* and the most up-to-date practices.

The other trend in the industrialised countries is towards the "internationalisation" of economic activity. In an attempt to articulate some boundaries for the concept, the OECD postulated that "Internationalisation" could be defined as:

> *The wide set of processes and relationships that result when previously fairly separate national economies become increasingly interrelated and economically interdependent with one another to an unprecedentedly high degree.*
>
> *These processes include:*
> *i) the export and import of goods and services;*
> *ii) the outward and inward flows of direct foreign investment;*
> *iii) the flows of science and technology;*
> *iv) trans-border data flows; and*
> *v) international movement of skilled personnel.*[3]

This process has been given momentum by the rapid advances of communications technologies; geography is losing much of its importance in the world of electronic transactions.

One salient feature of today's more internationalised world is the growing tendency for enterprises to lose their sense of national identity as reflected in their ownership, corporate culture or political allegiances. The pattern of technological development favoured by multinational firms has

long been a subject of policy concern. Recent studies tend to suggest that multinational enterprises see the establishment of technical facilities, including R&D laboratories, as an effective means of tapping into the scientific research activities of the host countries. This leads to the view that such enterprises utilise, and in time strengthen, existing S&T capacities rather than play a leading role in creating them in the first place. (These conclusions are based on work done in the industrialised countries.) The more complex the array of such subsidiaries a firm creates, the more extensive are its links to the global advance of science and technology. Such strategies by the multinationals create a range of policy challenges for developing countries.

Bringing the two trends together has seen the *"Globalisation of Competition"* emerge as a driving force behind the behaviour patterns of enterprises in the industrialised countries. Production has become more knowledge intensive, the pace of innovation has quickened, product life-cycles have shortened and the associated manufacturing techniques have changed from one product generation to the next. Companies have been obliged to spend increasing amounts on R&D to stay at the technological forefront of their industry. To lighten the burden of these costs, companies have sought new forms of partnerships which, in previous decades, they would have shunned.

So it can be seen that a primary concern of developed countries is to promote extensive innovation within their economies. This, in turn, calls for extensive cooperation among economic actors. OECD studies have shown that "the interaction with demanding and informed customers is an essential factor in both growth and industrial competitiveness".[4] But ECLAC goes further, to extend the importance of this interaction to meeting the needs of society's underprivileged. Their report argues that:

> *The present trend towards the consolidation of democracy in the region would be further strengthened by growth with social equity, but the erosion of equity would frustrate and weaken it, giving rise to social and political instability.....The most appropriate course is that based on the mobilisation of the most inherently legitimate instruments of democracy: participation and consensus-building.*
>
> *For this purpose, it is necessary - among other things - to organise the beneficiary groups since they are usually not only on the sidelines of the sources of economic power but also marginalised from social and political power. Indeed, the evolution of social policies in the history of the developed countries has gone hand in hand with the democratic*

organisation of society. The difficulty in the present circumstances, however, is that it is not just a question of empowering those who have hitherto been excluded in order to make the programme politically viable, but also of ensuring that they participate in a responsible manner, since it will obviously not be possible to fully satisfy their overdue demands in the short term.

Clearly, no programme for changing production patterns with equity can give good results without extensive consensus-building, and the overdue social demands can be kept under control only through a programme which assures broad participation by the people at large in the results.

Particularly in the case of the ECLAC statements, it is important to understand that the authors meant their policy considerations to cover agricultural activity as well as the industrial sector. In the developing world, it has been repeatedly demonstrated that a first priority must be to solve the problems of all segments of the agricultural sector - from the subsistence farmer to the export oriented commercial producer.

A global consensus of long term significance, on these same issues, was attained with the signing of the Rio Charter at the conclusion of the June 1992 UNCED Conference. The charter focuses on:

- the problems of poverty;
- the need for equity;
- the imperatives of sustainability;
- the need to actively promote the participation of traditionally disadvantaged groups and to empower those groups to act to bring about sustainable forms of development; and
- the need for developing countries to develop their own scientific and technological capacities in order to control their own development.

The charter commits all governments to work on a new "Agenda" for the next century. We believe that the principles negotiated at Rio are of sufficient, long-term, significance to be repeated here. They should be widely disseminated and discussed as South Africa seeks to redefine a S&T Policy for its future.

The Principles of the Rio Declaration are:

Principle 1 Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature.

Principle 2 States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental and developmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction.

Principle 3 The right to development must be fulfilled so as to equitably meet developmental and environmental needs of present and future generations.

Principle 4 In order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it.

Principle 5 All States and all people shall cooperate in the essential task of eradicating poverty as an indispensable requirement for sustainable development, in order to decrease the disparities in standards of living and better meet the needs of the majority of the people of the world.

Principle 6 The special situation and needs of developing countries, particularly the least developed and those most environmentally vulnerable, shall be given special priority. International actions in the field of environment and development should also address the interests and needs of all countries.

Principle 7 States shall cooperate in a spirit of global partnership to conserve, protect and restore the health and integrity of the Earth's ecosystem. In view of the different contributions to global environmental degradation, States have common but differentiated responsibilities. The developed countries acknowledge the responsibility that they bear in the international pursuit of sustainable development in view of the pressures their societies place on the global environment and of the technologies and financial resources they command.

Principle 8 To achieve sustainable development and a higher quality of life for all people, States should reduce and eliminate unsustainable patterns of production and consumption and promote appropriate demographic policies.

Principle 9 States should cooperate to strengthen endogenous capacity-building for sustainable development by improving scientific understanding through exchanges of scientific and technological knowledge, and by enhancing the development, adaptation, diffusion and transfer of technologies, including new and innovative technologies.

Principle 10 Environmental issues are best handled with the participation of all concerned citizens, at the relevant level. At the national level, each individual shall have appropriate access to information concerning the environment that is held by public authorities, including information on hazardous materials and activities in their communities, and the opportunity to participate in decision-making processes. States shall facilitate and encourage public awareness and participation by making information widely available. Effective access to judicial and administrative proceedings, including redress and remedy, shall be provided.

Principle 11 States shall enact effective environmental legislation. Environmental standards, management objectives and priorities should reflect the environmental and developmental context to which they apply. Standards applied by some countries may be inappropriate and of unwarranted economic and social cost to other countries, in particular developing countries.

Principle 12 States should cooperate to promote a supportive and open international economic system that would lead to economic growth and sustainable development in all countries, to better address the problems of environmental degradation. Trade policy measures for environmental purposes should not constitute a means of arbitrary or unjustifiable discrimination or a disguised restriction on international trade. Unilateral actions to deal with environmental challenges outside the jurisdiction of the importing country should be avoided. Environmental measures addressing trans-boundary or global environmental problems should, as far as possible, be based on an international consensus.

Principle 13 States shall develop national law regarding liability and compensation for the victims of pollution and other environmental damage. States shall also cooperate in an expeditious and more determined manner to develop further international law regarding liability and compensation for adverse effects of environmental damage caused by activities within their jurisdiction or control to areas beyond their jurisdiction.

Principle 14 States should effectively cooperate to discourage or prevent the relocation and transfer to other States of any activities and substances that cause severe environmental degradation or are found to be harmful to human health.

Principle 15 In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

Principle 16 National authorities should endeavour to promote the internalisation of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the cost of pollution, with due regard to the public interest and without distorting international trade and investment.

Principle 17 Environmental impact assessment, as a national instrument, shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment and are subject to a decision of a competent national authority.

Principle 18 States shall immediately notify other States of any natural disasters or other emergencies that are likely to produce sudden harmful effects on the environment of those States. Every effort shall be made by the international community to help States so afflicted.

Principle 19 States shall provide prior and timely notification and relevant information to potentially affected States on activities that may have a significant adverse trans-boundary environmental effect and shall consult with those States at an early stage and in good faith.

Principle 20 Women have a vital role in environmental management and development. Their full participation is therefore essential to achieve sustainable development.

Principle 21 The creativity, ideals and courage of the youth of the world should be mobilised to forge a global partnership in order to achieve sustainable development and ensure a better future for all.

Principle 22 Indigenous people and their communities, and other local communities, have a vital role in environmental management and development because of their knowledge and traditional practices. States should recognise and duly support their identity, culture and interests and enable their effective participation in the achievement of sustainable development.

Principle 23 The environment and natural resources of people under oppression, domination and occupation shall be protected.

Principle 24 Warfare is inherently destructive of sustainable development. States shall therefore respect international law providing protection for the environment in times of armed conflict and cooperate in its further development, as necessary.

Principle 25 Peace, development and environmental protection are interdependent and indivisible.

Principle 26 States shall resolve all their environmental disputes peacefully and by appropriate means in accordance with the Charter of the United Nations.

Principle 27 States and people shall cooperate in good faith and in a spirit of partnership in the fulfilment of the principles embodied in this Declaration and in the further development of international law in the field of sustainable development.

From this cursory review of some of the major policy documents germane to the development of an S&T Policy for South Africa, it is evident that other parts of the world are grappling with similar issues. While the work cited cannot substitute in any way for a vigorous debate on the future directions of South African policy, at least these international documents can help inform the search for viable policy options. It is clear that the goals of the Democratic Movement are shared by many societies.

Part Two:
Observations and Conclusions

Elements of a National S&T System

As we begin our review of current S&T Policy in South Africa, it is necessary to set the stage by outlining our view of what constitutes a national S&T system. It is our belief that a country should possess an array of institutions, in both the public and private sectors, which are capable of fulfilling the functions set out below. In some cases only a single institution is needed, in other cases a multiplicity will be required to meet the diverse needs of many sectors of national life. A national S&T Policy, therefore, should involve the following:

Policy and Regulatory Functions	Executing Mechanisms
Mechanism(s) to formulate policies, and, in some countries, plans for S&T.	Financing functions for research and for technological development;
Organisations to gather, analyse and disseminate information, including statistical information;	Mechanisms for evaluating and acquiring technologies
A capacity for forecasting and foresight, and for assessing the likely directions of technical change;	Institutions to execute research programmes
Capacities to regulate complex technological activities	Mechanisms to link R&D outputs to practical use
Mechanisms for the identification and protection of intellectual property	Facilities for the education and training of S&T personnel
Policies and programmes to maintain the vitality of the national S&T community	Mechanisms for the provision of technical services (e.g. metrology, standardisation, calibration)
	Links to regional and international S&T activities

Put slightly differently, a viable national S&T Policy needs to encompass:

- policies and programmes for the training of people at all levels (managers, researchers, engineers, technologists, technicians);
- policies regarding the organisation and funding of research and development systems and institutions and networks (with networks assuming an increasing importance, world-wide);

- policies to establish appropriate forms of governance and accountability for institutions within the S&T system;
- policies and programmes seeking to create healthy links between the research system and the productive sector, whether public or private, while at the same time acting to protect the public interest;
- policies to stimulate technical change, both radical and incremental, within enterprises;
- policies and programmes seeking to establish a vigorous role for the research community and the community at large, in the formulation of options for public policies;
- policies and programmes to promote unimpeded flows of scientific, technical, economic and social information both within the national system and internationally and regionally;
- processes for the effective integration of a government's S&T Policies with other economic and social policies of that government;
- the establishment of structures, which are transparent in their activities, for the management of overall policy and strategy for S&T over the long term - such structures being designed to accommodate the different, appropriate roles of ministers, and of officials, in the policy and resource allocation processes.

Additional considerations have to be brought to bear in countries with large disadvantaged communities who, traditionally, have been by-passed, and frequently further disadvantaged, by technical change. Work in many developing countries has underlined the absolute necessity of giving a voice to the disadvantaged in determining the appropriate goals of technological programmes to be pursued for their benefit. It is also of great importance that the social sciences attempts to understand the dynamics of change within disadvantaged communities be allied to all programmes of technical activity seeking to promote "development" among the poor.

Main Findings

The Mission's members believe it is necessary to repeat the caveat expressed to every group in South Africa with whom we held formal meetings. Our impressions of the current state of South African S&T Policy and practice are based solely on the opinions expressed to us, on documentation provided by institutions, and on background papers prepared by a number of independent researchers, at the request of the ANC Department of Research. We did not have the time, resources or mandate, to conduct in-depth evaluations of the programmes of individual institutions. We visited no research facilities and no projects of any kind. What we can offer, then, are two things.

First, we will attempt to hold up a mirror to show South Africans a portrait of the S&T system as it was described to us; and

Second, we will raise questions which, from our experience, we feel will be relevant to formulating a new S&T Policy for a new South Africa.

Throughout our meetings we were met with unfailing courtesy, and often great interest. One official, reflecting on the frustrations currently felt within government, went as far as to describe the discussions with the Mission as *"a breath of fresh air"*. Most of our questions were responded to with an air of complete frankness, but there were cases where replies seemed evasive. This created an impression that, below the surface, could lie the consequences of past decisions which would not withstand the force of external scrutiny.

Our impressions are of a highly fragmented group of institutions. These were often trying to define a role for themselves in the new South Africa, but were not quite sure how to go about it. These institutions also exist within an overall system which was most frequently described, by officials, as *"dysfunctional"*. What is clear is that South Africa badly needs a wide-ranging discussion of S&T Policy options of the kind which the Democratic Movement proposes to launch.

Some Overall Impressions

The Mission noted a series of recurrent themes in our discussions. These will have to be dealt with by a future, democratic government.

First, officials widely agreed that there is a leadership vacuum on S&T at the ministerial level. There are no articulated economic or social goals and

objectives towards which various institutions could apply their efforts. A new government will have to provide a framework for future policies, including those dealing with S&T.

Second, as a consequence of the policy vacuum, resource allocations are essentially frozen, subject only to minor variations approved by officials within a system which is non-consultative and non-transparent, even to other high-level government officials.

Third, there is a pressing need to rearrange priorities, both in general and in S&T in particular. This would involve recognising South Africa as an African country, rather than a white member of the industrialised world. In particular, South Africa needs to demonstrate that it can apply its technical skills to the real developmental needs of the majority - with at least as much skill and effectiveness as it applied them to the perceived "security needs" of the white minority.

Fourth, if the problems of the disadvantaged are to be tackled, there must be an unprecedented rapprochement between the community groups who can help articulate the needs and wishes of the poor majority, and the institutions of S&T, which have capacities which can be applied to meeting those needs.

Fifth, there is a crisis in the educational system at all levels. This crisis is at its worst when it affects the teaching of mathematics, science and engineering. Given our mandate, we have paid particular attention to the problems of tertiary level education, but we are fully aware of the gravity of the problems in primary and secondary schools.

Sixth, there is an immediate need to transform the highest levels of governance of the institutions of S&T. Government-appointed boards and councils must reflect fully the needs of the groups whom each institution is designed to serve. These structures must also contain the skills needed to address the objectives the institutions are designed to achieve.

Seventh, South Africa has to appreciate that it is part of Africa, and that it has experiences and knowledge to share, but that it also has much to learn from other societies. It should see itself as a participant in joint ventures in S&T on the continent, not as the automatic leader.

Eighth, all organisations, both public and private, need to make a real commitment to becoming non-racist and non-sexist. For a long time, this will mean an important commitment to national affirmative action programmes.

Ninth, deep-seated prejudices and intense resentment at past injustices will pose considerable impediments in the way towards the creation of a new South Africa. The S&T community - which has been privileged to receive very advanced levels of education - should be in the forefront of South African society in overcoming these obstacles and in working for the common good.

Tenth, as an example to all South Africans of how political life in this country can be transformed, we call on all members of the S&T community to become active participants in the public debate on the future directions of S&T Policy.

"The Republic of Science"

In the early 1960's in Europe, when discussions of the concept of National Science Policy were in their infancy, a paper[5] was published, which set out the ethos of those engaged in Fundamental Research. It proclaimed that science should be seen as apolitical, that scientific activity should be governed by researchers' intellectual interests and the stringent norms of excellence the scientific community alone could set for itself. As time passed, and the debates on science, and later, technology policy became more extensive, it became evident that the "republic of science" could only be, and should only be, a reality for a small minority of scientists and engineers. Most researchers find themselves engaged in activities whose goals are economic or social, rather than scientific per se, and finance for their efforts has to be found in competition with the resource needs of other societal needs. However, the Mission believes that the thirty-year old idea of a "republic of science", in its simplest formulation, is still, in fact, a guide to the operation of South Africa's long-term S&T Policy.

The Mission encountered several people who prefaced their discussions with the remark that science policy was a technical rather than a political subject. We cannot agree. Decisions, for example, that lead to heavy investments in research on proton beam therapy for cancer treatment - in a country with little or no research in the field of public health - represented intensely political choices, affecting as they did the allocation of significant amounts of public funds.

The Mission also believes that the expressed needs "to pursue excellence" and to "maintain international standards" were, in part, a rationalisation to justify low levels of resources allocated to redress the effects of apartheid on black members of the research community. Excellence and justice are not incompatible concepts.

Commentary on Individual Institutions

The Scientific Advisory Council

The Scientific Advisory Council (SAC) was established as the single most important source of independent advice on science policy and programmes to the South African government. Its terms of reference are broad[6] and in theory it has the ear of the government. Its legislation requires it to advise the Minister of National Education on:

- objectives of national strategy in the field of science;
- general areas of priority for R&D (taking into account socio-economic objectives);
- provision of scientific and technological manpower;
- promotion of the co-ordination of R&D;
- promotion of the use of research results;
- the operation of the science system;
- adjustments to the staff administrative norms and funding of scientific councils under a dispensation of framework autonomy; and
- interaction with neighbouring countries and the international scientific community.

In practice, the SAC is the target of extensive criticism from both within and outside government.

The first substantial handicap under which the council operates, is the cloak of confidentiality which surrounds its activities. No independent assessment can be made of the extent, quality, relevance or impact of its advice, in the absence of a public record of its activities.

The second handicap is its lack of an independent secretariat. The Department of National Education is an inappropriate source of secretariat assistance, since much of the council's work should involve critical analysis of that department and its management of the science vote. An example of the kinds of difficulties which arise when a secretariat serves two masters, is the recent decline in budgetary purchasing power of the statutory councils. The Department of National Education, as an executive arm of government, must accept that budgetary constraints on the present government have caused the purchasing power of statutory councils to decline by 25% since 1987, the

baseline year. One might have expected an independent analysis by the SAC to raise questions about the long term effects of such a decline. The SAC does not appear to have conducted such an analysis, since its chairman claimed in meetings with the Mission that, to date, all of its advice has been accepted by government. Advice in recent years appears to have been limited to issues which did not raise questions about the overall direction of government financing of R&D.

The third handicap is the vagueness of the SAC's responsibility for advising on matters of technology policy - following the demise of the council responsible. The SAC's membership, heavily weighted in favour of pure science interests , appears to believe that technology policy should not be within the SAC's mandate.

The overall impression we gained is that of a body which devotes its energies to matters of detail within the existing system, rather than taking a broad view, and tackling the many problems which confront South African S&T.

It appears that the SAC, as presently constituted and constrained, is not a useful mechanism for advising on S&T Policy. A new government, committed to participation by all South Africans in debates on public policy, *would do well to set up structures appropriate to this kind of political culture* - structures which would provide appropriate kinds of advice.

Other countries have tried different models, all aimed at ensuring that ministers have the best range of analysis available when difficult choices have to be made. Many governments use more than one approach. Among the popular models are:

- *The creation of a specific ministry to deal with S&T Policy*, either as a ministry in its own right (e.g. the German BMFT) or attached to another ministry. The practice of attaching a ministerial responsibility for science to a Ministry of Education has long been common, but in all cases this underplays the critical importance of Technology Policy. In many countries, the Ministry of Industry has either been given the mandate to deal with only technology, or, in some cases, to deal with science and technology. It is important that the minister responsible for S&T Policy be a member of the cabinet-level structure dealing with Economic Policy, to bring about a necessary integration of economic and technology policy;
- *The Advisory Council*, which may act as a confidential adviser, as is the case with SAC today, or might be seen as a mechanism for promoting wide public debate on issues of S&T Policy (the Zambian

Council for Scientific Research and the now defunct Science Council of Canada are examples). In all cases, the functioning of such bodies is closely related to the quality of the secretariat services which they have commanded;

- *The use of leading National Science and Engineering Institutions or Societies* as the source of opinion, prepared in response to specific requests from government (cf much of the work on public policy of the US National Academy of Science);
- *The encouragement of academic groups to work and publish in the field of S&T Policy* (cf the role played in the UK by the Science Policy Research Unit at the University of Sussex).

One model for the organisation of S&T within government which has fallen completely into disuse, for good reason, is the monolithic ministry, or Academy, which controls all research.

Framework Autonomy and the Statutory Councils

The adoption, by the South African government, in April 1988, of a system of "framework autonomy"[7] as the basis for the management of the statutory councils was a significant step; it terminated a system of excessive micro-management of the affairs of what were designed to be research institutions. Those institutions were then able to restructure themselves in ways in which they felt would best serve the needs of their clients. Today, this system applies to seven institutions:

- The Council for Scientific and Industrial Research (CSIR);
- The Human Sciences Research Council (HSRC);
- The Council for Mineral Technology (MINTEK);
- The Foundation for Research Development (FRD) (est Sept 1990);
- The South African Bureau of Standards (SABS);
- The Medical Research Council (MRC); and
- The Agricultural Research Council (ARC) (est Apr 1992).

To put them in some perspective, the following table shows their recent income:[8]

Total Income of Statutory Councils (FY 1987-1992) R-m

	1987	1988	1989	1990	1991	1992
CSIR	306.7	377.8	391.1	425.3	444.1	
HSRC	62.2	70.1	83.2	95.5	101.7	
MINTEK			63.5	72.2		
MRC			41.9	46.8		
SABS				91.0	107.1	
FRD					Not Comparable	114.5
ARC					No Data	No Data

The main features of the system of framework autonomy[9] are:

- **Clear delegation of authority and accountability to the boards and management of each council;**
- **A system of baseline funding for individual councils**

A major weakness of the new system has been the bureaucratic adherence to a distribution of funding based on the 1987-88 budgets of the then existing councils. This is compounded by having the baseline funds for most of the councils divided into two parts - one for the council's in-house functions and one for its "agency" responsibilities in support of research in the universities. (In the case of FRD, the division is between funds to support a series of expensive National Facilities, and the agency function which is the principal *raison d'être* of that Council.)

According to senior officials in those councils receiving these dual-purpose parliamentary grants which could not be re-allocated between those purposes, the current system appears to be managed solely by officials within the Department of National Education. We found no evidence that the existing Inter-ministerial Committee of Ministers responsible for the councils was in any way active in the process of resource allocations. Only in one case did we hear of a minister who was actively interested in the affairs of the council for which he bore parliamentary responsibility.

The Mission feels that a future government will need to:

- designate those S&T resource allocation decisions which it believes should be taken by ministers, and put in place

appropriate structures to ensure that ministers are able to take such decisions in full awareness of their impacts on the various parts of the national research system. Such a system should be informed by competent, external advice generated by a transparent process. This process should allow for significant inputs from all groups affected by the resource allocation process. We do not believe, based on the evidence shown to us, that this is the case today;

- ensure that other resource allocation processes are established within councils in ways that are transparent and that permit the respective boards to exercise the authority delegated to them; and
- in the light of the major responsibilities allocated to the council boards, ensure that those boards are constituted in a way which makes them fully representative of the constituencies which the individual councils are established to serve. This is far from the case in a number of the existing boards.

- **A requirement that much of the future funding be generated by contract from outside the council;**

The next table[10] shows the declining shares of total income of the five oldest councils - represented by their individual parliamentary grants. Note that there are discrepancies between the following two tables; one explanation may be that some councils counted interest income (surprisingly large in some cases) under the same heading as the parliamentary grant, while others have not done so. The data are in percentages.

Share of Statutory Council Income from Parliamentary grants

	1986	1987	1988	1989	1990
CSIR	66.2	67.0	62.7	57.1	56.7
HSRC	93.8	93.5	84.1	77.1	77.2
MRC	95.0	94.3	93.6	90.8	88.5
MINTEK	88.0	83.0	80.8	80.0	77.1
SABS	37.0	39.8	40.4	38.2	35.1

From data provided, we have constructed a table showing the share of the annual expenditures, of five of the councils, covered by external

revenues (from contract research, sale of services, sale of publications).

External Revenues of Statutory Councils (FY 1986-1991) expressed as a share of total income (Data are in percentages)

	1986	1987	1988	1989	1990	1991
CSIR	31.1	34.7	39.8	42.0	42.9	43.8
HSRC	5.1	14.5	20.7	21.5	22.7	27.1
MRC				7.4	7.7	
MINTEK				16.1	18.1	
SABS				56.9	56.7	

In principle, generation of external contract income by research institutions is good management practice, provided that the "customers" have effective purchasing power to allow them to arrange for contract research to be done.

A major shortcoming of the present system lies in the fact that only large industries, and some government departments, have budgets which allow them to commission research. As a result, at least one council is already generating a significant share of its income from offshore contracts. The government has entirely failed to address the lack of capacity of the disadvantaged groups to marshal the resources needed to commission contract research. There is a similar lack of capacity in small and medium-scale enterprises to satisfy their technological needs. Devising new ways of converting the needs of South Africa's disadvantaged into an effective (economic) demand for their satisfaction will be an urgent priority of a future government.

The Council for Scientific and Industrial Research

The CSIR represents a very significant South African investment in scientific research. It has modern facilities and a tradition of technical competence. In the years since the introduction of framework autonomy, it has conducted what has probably been the most thorough re-evaluation, undertaken by any governmentally created research organisation in the country, of its own performance, goals and strategy.

In earlier phases of its history, the CSIR saw itself as being similar to many government laboratories in the industrialised world - science driven,

emphasising the freedom of individual researchers over the existence of any specific corporate goals or strategy, a "university without the inconvenience of students" as one official put it. Outside, amidst the Democratic Movement, the CSIR was perceived as a part of the state's military-industrial complex, designated as a "national key point" and accorded special security status.

Since the beginning of this decade, the CSIR has gone about restructuring itself along the most up-to-date lines, to equip itself to play a leading role in making a post-sanctions South Africa capable of becoming internationally competitive in a highly technological world marketplace.

Along the way, it has commissioned reviews of policies for S&T in a variety of countries, from West and East, North and South[11], and has conducted a far-reaching management review[12] which has lead it to articulate a sophisticated concept of its own mission and of organisational initiatives designed to facilitate reaching that goal.

The Mission has a number of comments on the strengths and weaknesses we perceive in what has been done to date. We will link our comments to the needs of the three groups of clients the CSIR is seeking to serve.

The CSIR and large firms

The restructuring of the CSIR has been explicitly aimed at allowing it to serve the needs of large-scale industries facing decreasing tariff protection, the end of international sanctions and substantially increased international competition. It seems, from the description of the strategy adopted, that the CSIR has made the right moves internally to allow it to enter into strategic alliances with large enterprises. The CSIR is now technology and market driven and customer oriented. It is also, like the large similar government-created laboratories in the industrialised world, geared to cooperation with technologically sophisticated partners.

To its credit, the CSIR appears to have best articulated the different but complementary roles of board and senior management of all of the councils with whom we met. (In other Councils, we rarely heard their boards described as sources of strategic advice and counsel.)

The one topic we did not discuss with CSIR was their possible involvement in initiatives which might flow from the National Economic Forum, where COSATU, business and government are now discussing

specific technological initiatives which could be the basis of positive restructuring in some sectors of South African industry.

The CSIR and small- and medium-scale enterprises (SMEs)

The impact which CSIR restructuring will have on its capacity to respond to the needs of SMEs is much less clear and the treatment of this issue in the background papers which we cited is too cursory to be of much assistance.

The South African government seems to have studiously avoided experimentation with any policy instruments for the improvement of SMEs technological performance. No matter how "non-interventionist" they proclaim themselves to be, governments in all industrialised countries, either individually, or collectively in the case of Europe, have a wide battery of programmes to meet the needs both of the new, high-technology companies springing up with great rapidity in OECD countries, and of the multitude of other, traditional SMEs on whom many countries rely for the bulk of job creation in their economies.

Given the apparent lack of government interest, it is not surprising that the CSIR does not appear to be developing the array of industrial extension services, or financial support programmes, for in-house R&D in SMEs. Nor is the CSIR stimulating innovation, or technology transfer mechanisms and programmes geared to the needs of SMEs, which are to be found in many parts of the world. In some countries, in which support for both large and small enterprises is housed in a single institution, the competition for resources becomes intense.

The CSIR and community development

From the descriptions presented, the post-1990 CSIR is least well equipped to deal with the problems of disadvantaged communities. It has no experience in conducting research with specific goals which have emerged from long processes of consultation and discussion with disadvantaged communities. Nor does it have a long tradition of using social science research as a route to the interpretation of the complex dynamics of societies which are dramatically different from those of its researchers. There is a long, sad history, throughout the developing world, of well-intentioned technological interventions which failed - through a lack of understanding of how the beneficiary populations would react to technological change.

The recent move to add some social scientists to the CSIR is worthwhile. However, the council should consider reaching out to some of the

longer-established social science groups already working with communities. It is possible that partnerships could be forged to link the different competencies each body has to offer. The process will not be easy, but it could lead to much greater help being provided to communities in the long run.

The CSIR has already made overtures to institutions such as the World Bank, offering its expertise to the problems of other African countries. It would do well to spend some time discussing with major donor agencies the lessons of the past. A knowledge of "what has worked" in other developing countries might yield some clues as to how to maximise the council's contribution to tackling the backlog of needs to be fulfilled among South Africa's own poor majority.

As the CSIR continues to refine its corporate strategy, it should particularly examine its capacity to provide effective support to both SMEs and disadvantaged communities. In doing so, it need have no fear of compromising its standards of scientific and technical quality - some of the "simplest" technologies in the eyes of the user can be the fruits of highly sophisticated research.

The Human Sciences Research Council

The Human Sciences Research Council ranks among the most controversial research institutions in South Africa today. It is seen by many outside governments as having been irretrievably compromised as the source of much of the analysis that lay behind the policy of Grand Apartheid. No matter how much it seeks to reform itself from within - and the Mission was provided with extensive briefing on this "new" HSRC - it is still regarded with suspicion, even within parts of government. Some government bodies were noticeably uncomfortable when asked if their own needs for greater inputs from the social sciences could be met by collaboration with HSRC.

It is difficult to gauge the extent to which the work of HSRC has, in fact, been influential in setting government policy. In areas where it claims to have had an effect, a comparison with contemporary reality leaves much open to question. For example, claims that the 1981 de Lange Report on Education "paved the way for the transformation of education in this country", seem at odds with the reality of the crisis in education for much of South Africa's population.

We would have expected to find much larger HSRC-managed programmes aimed at developing black social scientists and the institutions

within which they work. Certainly, the foreign donor community active in South Africa in recent years sees this as a high priority. However, the share of HSRC resources devoted to this essential area does not appear to be commensurate with the magnitude of the task.

Of all of the statutory councils, it appears that the HSRC is the one which will enter a new South Africa with the greatest need to demonstrate that, in its present form, it is an appropriate instrument to assist in the development of future policy options. The Mission, composed of outsiders as it is, can perhaps be most useful in making some comment on international practice in the support of social science research in democratic societies rather than making specific suggestions about the HSRC per se. We would comment as follows:

- social science research has a significant role to play both in formulating options for public policy and in providing informed critiques of such policies; the outputs of both activities must be in the public domain, to inform political debate; and
- while some of the research needed by government can appropriately be purchased via contract, it is important that much of the activity be pursued in the public interest; this point was clearly made some years ago in the United Kingdom by Lord Rothschild when he argued that:

> *The need for independence from government departments is particularly important because so much social science research is the stuff of political debate. All such research might prove subversive of government policies because it attempts to submit such policies to empirical trial, with the risk that the judgement may be adverse. It would be too much to expect Ministers to show enthusiasm for research designed to show that their policies were misconceived. But it seems obvious that in many cases the public interest will be served by such research being undertaken*[13]

We suggest that, while formulating new S&T Policy for South Africa, thought is given to the pros and cons of having a body whose exclusive role would be to provide grants for independent social science research - whether carried out in the universities or in not-for-profit institutes which usually work in areas highly relevant to the needs of the disadvantaged majority. Such a body would in no way impede the commissioning of specific social science research projects by government departments, by periodic commissions of enquiry, or by private groups of any kind, as they sought to base their policies and programmes on a better understanding of South Africa's social dynamics. If such a body were to emerge, its governing board would have to be truly

representative of all parts of the South African population, as well as containing a broad range of expertise in research across the gamut of the social sciences.

We also believe that careful consideration - specifically not based solely on past HSRC activities - should be given to the question of whether or not there is an appropriate role, within government, for a body to conduct extensive programmes of in-house, social science research. Alternatives to the present could include the conversion of at least parts of HSRC to independent not-for-profit status. The new and potentially highly competitive budgeting system the HSRC is about to introduce will give its staff a foretaste of what it might be like to work in an independent research centre without an annually guaranteed funding base.

The Foundation for Research Development

The Foundation for Research Development (FRD) has emerged as the principal source of agency funds which support research and the training of researchers in the tertiary education system. A spin-off from the CSIR, it received its independent status in September 1990. In principle it deals with both universities and technikons. In practice virtually all resources for its human resource development mission are allocated to the universities.

According to FRD, its mission is:

> *The cost-effective and balanced provision of human resources and expertise in science and technology to meet the requirements of the nation.*

(Apparently an earlier version spoke of the FRD mission as supporting research, but the more recent emphasis is on human resource development.)

To implement its goals, FRD has undertaken to:

- maintain and foster research excellence;
- set its priorities according to future human resource requirements;
- develop and assist in maintaining the necessary infrastructure in education, research and training;
- selectively assist in improving and rationalising education and training at the primary, secondary, tertiary and occupational levels;
- assist in enabling disadvantaged communities to contribute fully to the pool of human resources;

- promote, develop and coordinate multi-disciplinary and multi-institutional cooperation;
- establish, reinforce and exploit international scientific contact and collaboration; and
- evaluate participants, programmes and their outputs.

The FRD has a second major responsibility beyond that implied in the above statements; it is the organisation responsible, at least on paper, for the management of three major national research facilities - the National Accelerator Centre (NAC), the South African Astronomical Observatory (SAAO) and the Hartebeesthoek Radio Astronomy Observatory (HRAO). Funds for the operation of these facilities are provided in a separate vote whose size, relative to the vote for the other FRD responsibilities, is determined outside the FRD - on the advice of the Department of National Education. According to FRD officials, the FRD acts only as a postbox, and exercises no substantive role in the management of the national centres. The table which follows sets out budget data for the full range of FRD activities for the current fiscal year.

The Distribution of FRD's 1992/93 Budget[14]

Agency Functions		National Laboratory Management	
Programme	**Budget**	**Facility/Programme**	**Budget**
Core Programmes	R30.2-m	NAC	R39.1-m
Bursaries	R13.7-m	SAAO	R6.5-m
Special Programmes	R18.8-m	HRAO	R3.3-m
Research Equipment	R2.0-m	International Liaison	R4.9-m
Scientific Services	R2.7-m		
Management and Administration	R7.9-m		
Subtotal	**R75.3-m**	**Subtotal**	**R53.8-m**

In many other countries, it has been found better not to mix, within a single institution, "agency functions" for the support of university activities, with any form of responsibility for the management of national facilities. In times of budgetary restraint, the institution will inevitably be drawn to protect its own employees. While the FRD currently does not have any budgetary discretion over the allocation of funds to national facilities, in the long run, some alternative administrative home might be found for maintaining any national programmes. In the following chapter, in a section dealing more generally with the financing of fundamental research, we return to the question of budgets for these facilities.

The Mission discussed, at some length, the adjudication processes used to allocate funds under the Core and the Bursaries Programmes. We found them well adapted to selection where the sole, effective criterion was technical merit. The policy problem facing the new South Africa will be to determine the proportion of its S&T budget to be allocated on this basis - as opposed to being directed either to specific problem areas or to bringing about a more rational organisation of tertiary level activities, both in teaching and in research.

Our view is that a significant share of national resources will have to be directed to the rationalisation of the tertiary system. Only then can institutions be set up to meet the higher education needs of all South Africans, and to conduct research on the problems of all parts of society, including, in particular, the needs of the disadvantaged. We will discuss our views on both the tertiary system and on conducting research for the disadvantaged later in this report.

Our impression of the FRD is that it has created a variety of useful channels (e.g. the University Development Programme, other special programmes to enhance activities in specific fields, and even a programme on the teaching of science in schools) through which to channel resources once South Africa has decided what it wants to do on these burning issues. However, it is clearly not the FRD's mandate to define a future strategy for tertiary education, or for research on the problems of the disadvantaged. Until a democratically elected government takes office, the FRD would be well advised to see that any additional resources it obtains are channelled into its Special Programme stream of activities rather than to its Core Programme.

The Medical Research Council

Although the Medical Research Council receives the smallest allocation of funds of all the statutory councils, it is the main channel for public sector funds in support of health research. Through its internal decision-making procedures, the MRC has the final say over the setting up of independent research units, institutes and centres which rely on its funding.

The research conducted by MRC staff, or university research funded by the MRC, traditionally focused on biomedical research. Research was based on the research interests of individual researchers, who in turn, were judged on their track records as researchers, rather than on the basis of any assessment of the health needs of the population as a whole. This discordance between research interest and public health need is nowhere more evident than in the expenditure (via the budget of FRD) of almost R40-million on the

National Accelerator. This was justified on the basis of its utility in the search for possible proton therapy treatment of a rare condition of oesophageal cancer. Research like this is clearly geared to South Africa's perceived "First World" needs.

South Africa currently boasts at least 14 Departments of Health - all with mandates to look after the health needs of different segments of the population. The lack of a coherent national health policy, and the lack of coordination of the delivery of health services has surely contributed to the lack of a coherent health research policy. The many faults in the system have been carefully documented.[15]

Since 1991, the MRC has attempted to shift the emphasis of its in-house research towards addressing wider needs. To this end, the 50% of the MRC budget traditionally allocated to its own institutes has been reallocated to a series of National Research Programmes in the areas of Tuberculosis, Nutritional Interventions, AIDS, Urbanisation and Health, Malaria, and Trauma. For the first time, research teams consisting of public health specialists, social scientists and other related researchers are participating, with their biomedical colleagues, in programmes aimed at addressing public health needs. In the words of the chairman of the MRC's board[16]:

> *This national programme structure makes provision for a portfolio of projects within a programme from the most basic to the most applied. Where the project is carried out depends on where the facilities, expertise and human resources are situated. In practice, the more basic projects will usually be carried out at the academic institutions while the more community-oriented projects, which are epidemiological in nature, will mainly be handled by MRC's own structures. The key to this system is that research will be carried out wherever it will be most effectively handled.*

The research is to be followed through to implementation. The MRC is to be encouraged in this new approach, and should set up evaluation systems to help keep the overall programme well targeted. A major policy question to be monitored carefully will be the extent to which this change of direction is carried through to the level of the practising researcher. Only time will tell. Even with this turnaround, major gaps remain, especially in the area of health policy and health systems research. These gaps would have to be filled if solutions are to be found to redress the imbalances in access and availability of basic health care.

Lack of trained manpower in the fields of public health, epidemiology, health policy and systems research will hamper, for some time to come, the MRC's programme of research in areas identified for "essential national research".[17]

Continued allocation of a significant share of the MRC's budget to university-based units, and centres for the conduct of basic research, can be questioned at a time when so much research is needed on how to tackle the basic health needs of "Third World" South Africa. What, for example, is the public health justification for continued expenditure on research on biomembranes, on the cell biology of atherosclerosis, on inherited skeletal disorders, on transplantation or on ecogenetics? The MRC should engage each of the groups it currently supports in a serious review of the public health contributions to be expected of their programmes.

An articulate statement of some of the challenges of community health research was made by two South African academics[18] who saw them

> *...stemming from the very nature of community health - how to empower communities so that the content of research is determined by the participation of communities*

We cannot judge the extent to which the MRC's new national programmes would meet this challenge.

The MRC has traditionally had research links with institutions in the developed countries. Now, however, it needs to develop and strengthen ties with African and other Third World research institutions, in order to address the current health needs of the majority. As an example, the work on AIDS could certainly be informed by access to results of work done at the universities of Nairobi and Makerere.

Major efforts will be needed to strengthen the training of specialists in public health. There are already two initiatives, each involving more than one university, seeking to establish two schools of public health. However, there is no recognised forum in the South African health system where the question of the appropriate pattern of development of public health training facilities could be broached. This is yet another vacuum at policy level.

Specific attention must be given to the historically black universities (HBUs). Their capacity to train competent health practitioners and researchers should not be undermined by a system that automatically situates new capacities in the already strong institutions. Only sustained effort with the historically black universities will bring any hope of redressing the gross

inequities of race and gender to be found within South Africa's health systems.

The Council for Mineral Technology (MINTEK)

Given the important position of the minerals industry in the economic life of South Africa, it is not surprising to find a sixty-year-old institution playing an important role in mineral technology development.

In some important ways, MINTEK has a privileged position among the statutory councils. It has a clearly identified and technically sophisticated clientele - the major mining houses. Given this important advantage, it appears that MINTEK has paid serious attention to technology development and technology transfer, and is able to document significant contributions to the mineral industry over a long period of time.[19] Its close interaction with minerals companies, during the process of technology development, has undoubtedly played an important role in the final transfer of new technologies into use.

The arrival of "framework autonomy" appears to be having paradoxical results for MINTEK. It appears that South African mineral producers, having been accustomed to receiving MINTEK services free of charge, now are reluctant to pay contract fees (the companies argue that their large annual tax contributions are sufficient payment to government!) As a consequence, "international" contracts have risen from 1% of total contract income in 1987 to almost 50% of that income in 1991.

According to its 1991 Annual Report, R&D contract income in recent fiscal years rose as follows:

MINTEK R&D Contract Income

	1986	1987	1988	1989	1990
R&D Contracts (R-million)	4.4	6.4	8.0	10.4	13.1
Contracts as a share of total	12.0%	13.9%	14.6%	16.4%	18.1%

It may be that the global recession has influenced the mineral industry's attitude to financing work in MINTEK. However, those companies should be aware that their international competitors are showing increasing interest in joining consortia to finance pre-competitive research. Such behaviour was unheard of in the past. It will be in the interests of South

Africa's mineral industry to map out a joint long-term research programme with MINTEK, and to be prepared to finance an increased share of the activities. If the industry fails to do this, MINTEK's capacity may well be increasingly utilised by the industry's offshore competitors, or MINTEK might be forced to reduce its scale of operations - if future governments cannot maintain the present level of expenditure in the face of intense competition for resources in future budgets.

The Mission does agree that there is a floor level of government funding which ought to be maintained to allow MINTEK to stay ahead of the industry and its needs. The proportion of government funds in a future MINTEK budget should certainly not fall below 25% or 30% of total, but there is much room for the industry to expand its financing.

MINTEK has an "agency role" and spends about 2% of its budget (today almost R1.6-million) on financing research in the universities. However, unlike the other statutory councils, MINTEK views this funding as an integral part of its own programme. There is extensive interaction between university-based researchers and MINTEK staff in the definition of projects to be supported by these funds. Given MINTEK's mandate, this is good management of a scarce resource, and it contributes to the impression of there being a national programme of mineral technology development.

In the past, MINTEK worked very closely with selected universities to develop university capacity in fields of emerging importance to the minerals industry. Such support has gone beyond the simple transfer of funds, and has included the secondment of MINTEK staff to selected universities for several years to assist in setting up new programmes. (It might be instructive to examine this model as one which could be used to strengthen the research and teaching functions in selected university or technikon departments - as part of a national effort to upgrade the tertiary education system.)

The South African Bureau of Standards

While most attention in S&T Policy is devoted either to R&D or to technological innovation, there are a range of scientific activities which must take place for an economy to be internationally competitive. One area of crucial importance to industry is the establishment of standards and the certification of products and processes. It is in this essential area that the South African Bureau of Standards works.

The SABS is the only statutory council which is not a "research" organisation. It is however a very sophisticated technological organisation

whose performance is important to all South African industries and, ultimately, to the South African consumer. As set out in its own profile of its activities:[20]

> *SABS concerns itself mainly with the development of standards for products and services, and is responsible for the Administration of the Mark Scheme and the Listing Scheme to regulate the application of such standards by industry. It also offers a consignment inspection scheme; administers compulsory standards, and provides testing and related services.*

While maintaining technical standards is important in a domestic context, it is crucial in international trade. SABS participation in the International Standards Organisation has allowed it to offer detailed services to South African companies seeking to trade in international markets.[21]

In the field of quality control, international practice has moved to ensuring that the issue receives detailed consideration throughout individual firms, rather than being the sole concern of a quality control unit. An international standard for firms practising "total quality control" (ISO 9000) has been developed, and the Mission was impressed to find that SABS has been qualifying South African companies to that standard for over a decade. While, during the era of sanctions, the main demand for high levels of quality control may have come from the military, it is certainly true that all South African exporters will increasingly find that quality assurance is an important element in international competition. The drive to bring more companies up to this international standard is one which should be supported by any government.

An interesting development, on the international front, is that South Africa, via the SABS, is participating in discussions around a scheme to certify companies' environmental performance - in much the same way as quality is graded.

The financial structure of SABS is markedly different from that of other statutory councils. It appears to operate with an annual income which is in excess of its expenditure. According to its 1991 Annual Report, the overall financial structure of the SABS, for the fiscal years 1991 and 1990 was as follows (in R-millions):

SABS Financial Structure

	1991	1990
Operating Income	60.7	50.1
Interest Grant	11.4	7.4
Parliamentary Grant	35.0	31.9
TOTAL INCOME	107.2	91.0
Expenditure	84.3	70.8
NET INCOME (after adjustments)	18.4	11.8

The SABS operates a Building Fund, into which a small share of the parliamentary grant is placed, a "General Fund" and a "General Reserve" - between them, these accounts contain a capital holding of very close to R125-million.

Unlike other councils which have reduced staff numbers, the SABS has grown. This is due, in part, to the growing requests for testing services from companies who need these services, but who are unwilling to establish their own facilities in time of recession.

An important justification for the continuation of government funding of an important element of SABS activity lies in SABS role in the determination of "National Standards". Complete private funding of SABS would create at least the impression, that such standards would be drafted with the financial interests of the main funders clearly in mind.

The Atomic Energy Commission

The Atomic Energy Commission appears to have few friends. Among the members of the Democratic Movement it is seen as part of the state's military-industrial complex, while in many parts of government it is seen as a huge drain on resources.

The Mission has been able to piece together the following information which may be germane to a future government wrestling with resource allocation decisions:

- The AEC's present budget is apparently of the order of R700-million - that is about 70% of the annual budget administered by the Department of Mineral and Energy Affairs.
- Given South Africa's abundant coal reserves, and Southern Africa's huge untapped hydroelectric potential, no further construction of

nuclear electricity generating capacity is likely for many years to come.

- Since 1986, the AEC's employment has been cut by more than 50%, down to its present level of about 3400 people.
- The AEC currently spends "about R80-million" per year on technology development (i.e. the AEC's own research budget). Of this, about 3% is used to commission research in the universities.
- The non-research funding allocated to the AEC, which appears to be of the order of R600-million per year, must presumably be allocated as support to its various production activities, including the production of nuclear fuel and other products.
- The AEC estimates that it will sell about R70-million worth of nuclear fuel per year to ESKOM for each of the next five years, and that its sales of non-fuel products will rise from under R50-million in 1992 to over R150-million by 1997. These figures, when contrasted with the annual government subsidy, should give rise to serious questions about the long-term economic justification for government support of the nuclear programme in its present form.
- According to government observers, much of the AEC's activity was developed as response to external sanctions and to governmentally defined "security needs", which entirely ignored any factors relating to the commercial viability of processes being developed. As sanctions disappear, and as a new government redefines its perceptions of South Africa's needs and priorities, it seems obvious that a rethinking of the country's commitment to a nuclear programme will be imperative. Given the existence of one successfully operating nuclear plant, South Africa will have long-term nuclear obligations to fulfil, but that does not automatically mean that all elements of the AEC programme should be subsidised in perpetuity. Hard choices will have to be made, and these will inevitably have implications for the size and focus of any continuing South African nuclear research activity.
- Given the investment made to date, we have no doubt that South Africa will have built up, within the AEC, a considerable and broad competence in a variety of high technology areas. Careful attention should be paid to the possibilities of redeploying this valuable capacity in support of non-nuclear industrial activities, as has been done within the nuclear programmes of some industrialised countries.

Commentary on Some Key Sectors

The Tertiary Education Sector

The tertiary education sector in any country plays a vital role, both in the advancement of knowledge, through its research function, and in the training of people for productive roles in society, through its teaching function. In turn, the tertiary system is dependent, in large measure, on the flow of young people from the secondary education system.

From our observation of the present state of tertiary education in South Africa, we have become aware of an array of substantial problems in general, plus an additional set of problems affecting science and technology in particular. Many, but not all, of the problems stem from the enduring legacy of apartheid.

The universities see themselves as being divided into two groups: eleven "historically white" (HWUs) and ten "historically black" (HBUs). The white universities tend to have mostly white faculty members, and only a small, but in some cases growing, minority of students who are black. These institutions tend to have all the faculties one would expect in a modern university, and they attract the lions' share of all research funding allocated on the basis of "excellence". The black universities tend to have faculty members of all races, and a student body which is largely black. Typically these universities will not have all of the faculties of a modern university. For example, only one has a faculty of engineering. Their success rate in competition for research support is low. (The Mission has seen no data on the levels of staff qualification typical in the two sets of universities). The Mission also became aware of a deep sense of rivalry between and among these institutions and their staffs - any rationalisation of activities will have to seek to overcome these rifts.

Similarly, of the fifteen technikons, seven could be categorised "historically white" (today more than 75% of their student population is white)[22], and eight where the student body is predominantly black. All technikons suffer from disadvantages in funding (the state formula for financing technikons is even less adequate than the formula used to finance universities.) These institutions are seriously engaged in attempting to improve the recognition of the role which they play in tertiary education. This campaign involved a demand to have the right to grant degrees. The technikons are also seeking increased recognition of their role in research.

The existing funding system for institutions of tertiary education is based on a formula related to student numbers. The existing formula is believed by many to provide insufficient recognition of the differential costs involved in providing education in different fields. In particular, many believe the existing formula does not adequately reflect the cost structure of education in the sciences and engineering.

There are three main avenues currently used to finance research in the tertiary education sector - there is:

- an element of formula financing, administered by the Department of National Education, related to the publication of some books and of papers in "approved journals". There is some support for this approach by the research-intensive universities, but also criticism of various ways in which this particular system can be manipulated. There is general agreement that it is to the benefit of the institutions that some share of research financing be passed through the institutions rather than all being channelled directly to specific research groups;
- direct support of researchers or research groups, provided by government via the "agency function" of various statutory councils. To differing degrees in the different councils, these funds are allocated to "open competition" among scholars (selections are based on merit), and "special programmes" which may be designed to increase activity either in designated fields of research or by designated institutions. A key policy issue here is how the relative allocation of funds between these two channels is determined; and
- contract research, financed by government councils or departments, by private enterprises, or by foreign donors (this latter, foreign, channel being important in terms of making funding available for research on the problems of disadvantaged communities).

The Mission believes that all of these diverse channels of funding research in the tertiary education sector should continue.

We did find it difficult to get a single, authoritative view as to the volumes of funds flowing through each of these channels. Earlier, we showed some data on agency funds which individual statutory councils administer. However, we have seen no estimates for funding provided to tertiary educational institutions via the Department of National Education's formula for research support. Nor have been seen a comprehensive accounting of the amounts of R&D support provided by government departments. The most comprehensive treatment is that afforded by the Department of National Education's biennial survey, whose data we use.[23]

Funding of R&D in Tertiary Level Institutions, by Source, for Fiscal Year 1989/90[24] (Data are in R-million)

	Govern-ment	Tertiary Sector	Business Sector	Not For Profit (NFP) and Foreign	TOTAL
University Natural Sciences	51.1	240.4	43.7	1.0	336.2
University Human Sciences	5.5	160.9	8.0	1.6	176.0
All University R&D	56.6	401.3	51.7	2.6	512.2
Technikons	0.02	5.4	0.0	0.0	5.2

To try to get a feel for the magnitude of the discrepancies in R&D funding between the historically black universities and the historically white Universities we have reviewed the data published by the Department of National Education.[25] The HBUs covered are the Universities of Durban-Westville, Western Cape, Vista, Zululand, The North, and Medunsa; no data is provided for the Universities of Fort Hare, Venda, Transkei or Bophuthatswana. The HWUs covered are the Universities of Pretoria, Cape Town, Witwatersrand, Natal, Stellenbosch, Orange Free State, Potchefstroom, Rhodes, Port Elizabeth and the Randse Afrikaanse University. Data for the University of South Africa (UNISA) have been omitted, given that institution's special character as a distance education facility working primarily via correspondence courses. The data are for 1989/90, that is, for a period before the introduction of the FRD's University Development Programme.

Research Support, by group of university, and by source of funding (Data are in R-million)

	Government	Tertiary Sector	Business Sector	NFP and Foreign	TOTAL
Natural Sciences					
HBUs	0.5	21.9	1.2	0.0	23.6
HWUs	50.5	212.6	42.5	1.0	306.6
Human Sciences					
HBUs	0.5	14.3	0.2	0.0	15.0
HWUs	4.7	110.7	7.8	1.6	124.8

The extent of the disparities are huge and we have seen no data which would indicate that the gaps are being narrowed to any significant degree.

The Mission was dismayed to discover that the executive of the Committee of University Principals had never discussed research policy as it affects their institutions. This body appears to devote its energies to the discussion of administrative matters. While these matters are important, in other countries they would be the responsibility of other, less senior, university officials. In sharp contrast, the Committee of Technikon Principals, who face a range of problems at least as difficult as those confronting the universities, appeared to have selected to tackle a set of issues that go to the heart of their institutions' mission and ethos. They also appeared to be making some progress in developing a common front among institutions which were historically racially divided.[26] There are a series of significant distortions in the patterns of enrolment in tertiary education in South Africa, as shown in the 1989 data in the following table.[27]

Number of Students per thousand of Population

Population Group	Number per Thousand	
	Universities	*Technikons*
White	31	10
Indian	20	6
Coloured	6	2
African	4	0.5

As can be seen, not only are there inter-racial distortions, but also an unusual imbalance between the numbers obtaining university education, as compared to those in the technikon stream. In most countries, technikon students would far outnumber those in the universities. We are certainly not seeking to imply that the numbers of university students are too high, but rather that the numbers of technikon students seem to be far too low.

There appears to be broad agreement on the magnitude of the problem of education for black students at the secondary school level. According to FRD data, for every 10 000 Africans who enter primary school each year, only 113 will pass the Matric examinations. Of these, only 27 will receive a "matric exemption", and, of the 27, only one will have an exemption in maths and science. Given that about 800 000 pupils enter Grade 1 each year, it means the educational system produces about 80 African people per year who have the paper qualifications to proceed to university in maths, science or engineering. The overall data on students within different levels of the education system presented to us by FRD are the following:

Students Within Different Levels of the Education System

	Grade 1	University	Technikon
African	799 984	91 462	9 654
White	81 044	156 737	47 662
Asian	21 335	19 179	5 558
Coloured	109 358	18 968	5 444

A new government may well decide to prioritise the upgrading of primary and secondary schooling. However, making significant inroads into redressing the large problems of black education will be a lengthy process. It will involve upgrading teachers' qualifications, improving physical facilities, and so forth. While this necessary process is pursued, the system will still produce large numbers of poorly trained students who will need significant help to improve their basic knowledge and skills, in order to proceed to higher levels of education and training. This will give rise, for a considerable period, to a heavy demand for remedial courses. While existing efforts, such as that represented by the College of Science at the University of the Witwatersrand, are good pilot schemes, ways and means will have to be found to make such courses more widely available. This will of course add pressure to educational budgets - forcing educators to be innovative in their use of physical facilities.

In addition to the overall problems of inadequate black schooling, there is a second important trend - the trend away from tertiary education in science and engineering. The share of South Africa's university student population involved in science and engineering is already low in comparison to many rapidly developing countries. Data presented to the Mission indicated that the share of graduates in science and engineering, as a proportion of all graduates, declined over the last five years in every South African University, without exception.

There is substantial controversy surrounding the issue of restructuring the tertiary education system in South Africa. Some feel that any rationalisation will inevitably mean the historically black universities will be relegated to a second-class role, as "teaching colleges" with little or no research. Equally, there are those who fear that massive affirmative action to upgrade the historically black institutions will imperil the funding of those institutions which have already established themselves in positions of research strength.

Throughout this, examples of inter-institutional cooperation are few. (The main examples revolved around the creation of two schools of public health, one based on joint efforts by the University of Western Cape and the

University of Cape Town, the other involving the Universities of Witwatersrand, Pretoria, Medunsa and the University of the North.)

In the developing world, there are many examples of activities aimed at strengthening individual departments, faculties or entire institutions in developing countries through "twinning programmes" with institutions of tertiary education in the North. Such programmes usually involve exchanges of staff and students, joint curriculum development, and joint research. Perhaps such an approach could be attempted within South Africa, with well-established faculties or departments playing a significant role in strengthening their weaker partners.

The future direction of Tertiary Education Policy is of such crucial importance to S&T Policy, that we will return to this matter in the concluding sections of our report.

The Industrial Sector

Our impressions of technology policy to support South African industry were obtained through interviews with the Department of Trade and Industry, CSIR, South African Bureau of Standards, SACOB (the South African Chamber of Business), MINTEK, ESKOM, and the AEC. From our discussions, we formed the following impressions:

- The South African manufacturing industry is characterised mainly by large companies, many of which are subsidiaries of foreign corporations. Most perform very little R&D within South Africa.
- There is a relatively small number of small and medium sized enterprises which show the capacity to innovate.
- Government policy recognises the need for South African enterprises to be competitive on world markets and wishes to stimulate innovation, but that recognition has failed to be translated into a comprehensive national technology policy.
- Government, to date, has acted by:
  - (a) providing baseline funding to the CSIR, SABS and MINTEK; and
  - (b) helping to finance a scheme which promotes innovation in the electronics industry, and is considering the expansion of this to other industrial branches. However, we have noted that the sums spent on the electronic industries scheme are significantly smaller that the value of contracts placed by private

corporations with the statutory councils. South Africa is the only country, of which the Mission is aware, in which there is a net flow of direct financing of R&D *from* the private sector *to* the public sector.

Most industrialised countries have developed a variety of tax incentive measures to stimulate R&D and technological innovation. The South African government, however, treats R&D expenditures as an ordinary business expense for tax purposes. We were cited examples where existing South African tax policy acted as a disincentive to industrial development. For example, it was argued that an existing 35% tax on gold has made it difficult for a jewellery industry, which is potentially labour intensive, to expand.

SACOB is one organisation which is taking the issue of a future technology policy in support of industry very seriously. It believes one of the principal challenges facing a future government will be to remove the many distortions within the South African economic system - these were created by past isolationist, protectionist policies, and the "security interests" of a state faced with extensive international economic sanctions. SACOB favours discussing industrial policy and strategy within the National Economic Forum. It believes also that technology policy discussions should, separately, address the issues of manufacturing, quality of life, services, and infrastructure. SACOB made clear that, as representatives of industry, its members believe that the current government, and in particular the Department of Trade and Industry, has been much too cautious in experimenting with a range of policy instruments which many other governments have found helpful in creating an environment which favours innovation by enterprises.

There was surprisingly little reference, in any of our discussions, to the technological needs of small and medium industry, nor to the need to stimulate rural industry. In other countries, governments have played a significant role in stimulating innovation in SMEs. We believe it would be useful for the National Economic Forum, and for SACOB, among other bodies, to study these experiences and assess their relevance for South Africa.[28] On page 59 is a table which seeks to characterise, in a general way, typical attitudes to R&D of different classes of companies around the world, both in industrialised and in developing countries. Formulating policies, particularly for SMEs, should take full account of their typical patterns of behaviour.

International experience also demonstrates that international competitiveness depends on a firm's ability to innovate. This will sometimes involve the firm in making radical changes to existing technology. More

commonly, it will involve groups of engineers and workers making many small incremental changes. Competitiveness depends crucially on the ability to make incremental changes, and this in turn means a capability *within* the firm to manage these changes. Government research organisations such as CSIR will have little impact on industry unless they have the internal capacity to innovate. More attention must be given to training creative engineers who can introduce technical change, as well as managers of technical change.

The rest of the world is devoting increasing attention to worker training as an essential strategy to harness technological change. South African firms, too, must address the need to continually upgrade the skills of their workforces. Studies in the OECD countries[29] have suggested that, while employers show strong support for literacy programmes, they rarely match their rhetoric with significant action. We do not know if South African employers, as a group, treat this issue more seriously. Other issues which will need to be resolved include:

- the extent to which SMEs might provide opportunities for employment creation;
- how the South African manufacturing industry can be re-integrated into the global economy and be encouraged to participate in collaborative research and strategic alliances;
- the extent to which government support for innovation should be redirected to the needs of the disadvantaged majority. Such a redirection could imply a cut-back on government support for innovation to make South African industry more competitive on world markets. This would place an increasing onus on firms to invest in their own competitiveness; and
- the extent to which South Africa's armaments industry, and its expertise in military technology, can be converted for civilian objectives. This is a complex issue which is of concern to many countries, including the former Soviet Union, the USA, China and several European countries. In both the United Kingdom and Sweden, there is a process under way to convert former military microbiological establishments to fully civilian scientific institutions.

In trying to formulate policies for the support of technological development in SMEs, one must take into account the significantly different attitudes different classes of enterprise have to R&D and to technological innovation. We summarise some of these in the table which follows:

Large Enterprises		Small & Medium Enterprises	
MNC's	**National Companies**	**New Technology-based Companies**	**"Traditional" SMEs**
Dependent on extensive inputs from R&D in a wide range of fields to retain competitiveness.	Usually under-invest in R&D; in protected markets they show no inclination to innovate.	R&D essential to their existence. Many were created by former university researchers.	Usually unable to identify their own technical deficiencies or needs; have zero contact with R&D.
In addition to having in-house R&D capacity, increasingly involved in R&D consortia involving other enterprises; have wide range of relationships with developed country universities.	May have some contact with government R&D facilities, mainly for trouble shooting rather than long-term development; prefer to purchase or import technology rather than to engage in its development.	Likely to have good contacts with universities since they are in fast-moving fields. In fact, the greater their in-house R&D capacity, the more sophisticated is likely to be their strategy for dealing with university researchers.	Rarely have any contact with their national S&T community unless the local R&D institutions have made special efforts to get in touch.
Highly developed internal systems for technology transfer among affiliates.	Technology importation done as discrete contractual arrangement no as part of a continuing relationship.	Many sell technology rather than manufactured products.	Usually use outmoded technology; resistant to change.
Generally have good links between R&D function and production.	May have poor to non-existent links between R&D and production.	R&D is the heart of the company which lives or dies by its ability to commercialise new technology.	Have limited access to capital for upgrading their technology.
			Need access to proven technology.

Research in Agriculture

The salient points about the present state of agriculture and agricultural research in South Africa are the following:

- "White" commercial agriculture, with significant but unquantified long term financial support from the state (primarily via long-term credits at low interest), has been able to make South Africa self-sufficient in food production. However, the prolonged drought in the region is having extensive effects. Past policies - which supported crop production on unsuitable land - are showing up as important problems for the "white" Department of Agriculture.

- Only on 1 April 1992 was the Agricultural Research Council organised as a statutory body. It was made up of the former research groups within the "white" Department of Agriculture, thus giving governmental agricultural research, *for the first time*, a legal mandate to consider the problems of black farmers throughout South Africa.

- The lack of official knowledge of the demographic features of the rural population in South Africa is appalling. The most recent census used aerial surveying as a technique for estimating rural populations. This method is universally believed to be entirely unreliable. It is believed that the rural population is best thought of as two groups:

    1) a large, group of "displaced urban dwellers", forced by apartheid to live on marginal rural land. These people subsist primarily on remittances from urban males. The size of this population is unknown, as is its composition; and

    2) a possibly much smaller, traditional, rural peasant population, again unquantified.

- Furthermore, there is little available information on the flow of people in search of employment into the urban areas, or of the possibly increasing flow of males back to the rural areas as a consequence of escalating levels of black unemployment in the urban areas.

- The question of land, its ownership and its use, lies at the heart of some of the most difficult issues which will face an Interim Government and a later, democratic government operating under a new constitution. (The ARC does have expertise and information relating to the agricultural potential of lands within South Africa, which should become part of a national geographic data-base.) Until the question of land title is resolved, the process of planning for rural development, including agricultural development, will remain almost hopelessly complicated.

- Despite the existence of at least fourteen separate departments of agriculture, a number of Agricultural Development Corporations in the various homelands, and the Development Bank of Southern Africa, there appears to be no overall understanding of the potential role of peasant, subsistence, or even small-holder agriculture as a source of livelihood for at least some of South Africa's disadvantaged populations. The problems of such small farmers, and the difficulties which they are struggling to surmount, are at least partially documented in a recent World Bank study.[30]

- The ARC, which represents about half of the agricultural research capacity in South Africa, (with the remainder being principally in the universities and the private sector) appears to have no experience of the "farming systems approach" developed by the International Agricultural Research Centres of the Consultative Group on International Agricultural Research, together with a variety of regional, national and bilateral Donor Agencies active in the developing world. This approach is considered an essential element in any attempt to assist subsistence farmers.

- There is external criticism of ARC from other government bodies - on the grounds that it consumes a disproportionately high share of governmental science expenditure. One estimate[31] indicates that 35% of government R&D expenditures are allocated to Agriculture, Forestry and Fishing which make up only 7% of the (formal sector) GDP. However, even this document did not contain budget figures for the ARC. Some data on 1989/90 R&D expenditures, published by the Department of National Education[32] are shown in the table below. (Data are in thousands of Rand)

R&D Expenditures in Agriculture

	Govern-ment	Tertiary Education	Business	NFP and Foreign	TOTAL
Agriculture, Forestry and Fisheries	146 803	67 197	50 695	11 823	276 519
All R&D	578 008	517 565	656 951	21 923	1 774 447
Agriculture as a share of TOTAL	25.4%	13.0%	7.7%	53.9%	15.6%

- In the reorganisation which gave birth to the ARC, all the agricultural economists in the "white" Department of Agriculture remained in the

department. The ARC must have access to social science capacity, including agricultural economics, if it is to successfully develop a programme of research to assist small-holder agriculture. A group of economists whose mandate is limited to considering the problems of commercial agriculture is not the answer.

Environmental Affairs

At the beginning of this report we singled out three concerns which dominate international thinking on S&T Policy: competitiveness, equity and sustainability. We discussed the ideas and practice of sustainable forms of development in meetings with the Department of Environmental Affairs.

The Department of Environmental Affairs, as presently constituted has four components:

- a Chief Directorate of Marine Fisheries, essentially involved in the management of renewable marine resources. The titles of the research which this directorate supports suggest an appropriate emphasis on understanding the population dynamics of commercially important fish species.[33] This allows the directorate to set appropriate annual harvest levels. According to the data provided there will be an expenditure of R17-million on this research, which is principally carried out by departmental staff. We did not enquire about the detailed functioning of this research section;
- a Weather Bureau, which finances a some research, including a controversial weather modification project, Cloudquest (Budget for 1992/3 R4.2-million);
- an Antarctic Programme, managed in conjunction with the universities (Budget about R4-million); and
- a Chief Directorate for Environmental Conservation which receives 15% of the overall departmental budget and whose research budget is displayed below:

Department of Environment Affairs Research Support for Environmental Conservation (FY 1991 and 1992)

	Financial Year 1991		Financial Year 1992	
	R-millions	%	R-millions	%
Nature Conservation	2.007	23	1.897	21
Pollution Control	1.002	12	0.870	10
Resource Utilisation	0.494	6	1.171	13
Rivers and Wetlands	1.327	15	1.693	19
Coastal Management	1.539	18	1.064	12
Information Services	1.572	18	1.234	14
Legislation	0.525	6	0.949	10
Cultural Resources	0.225	3	0.177	2
Education	0.0	0	0.065	1
TOTAL	**8.691**		**9.120**	

As with many other fields of jurisdiction in South Africa, environmental matters are fragmented:

- air pollution is the responsibility of the Department of Health;
- water pollution is the responsibility of the Department of Water Affairs (which may also have jurisdiction over solid waste disposal in as much as ground water quality is an issue);
- soil erosion is the responsibility of the Department of Agriculture; and
- control over nuclear operations is the responsibility of the Council for Nuclear Safety.

In addition, we were told by officials that, since 1986:

> *Executive functions concerning the environment have slowly been devolved to lower levels of government...[but that] the problem is that lower levels of government don't have the capacity or expertise to deal with many of the issues that relate to the environment.*

The present government (at least in matters of environmental regulation) was described as preferring to "govern by persuasion and by self-regulation". Officials say that the Department of Environmental Affairs "is weak in the area of the human living environment but strong on endangered

species and wildlife conservation". These relative strengths and weaknesses are reflected in the current pattern of research funding!

The department has held consultations on a draft White Paper on *"Policy on a National Environmental Management System for South Africa"*. The draft clearly reflects the struggle to come to terms with the interrelated nature of environmental sustainability and development (often inappropriately considered to be simply equivalent to economic growth). For example, the very first principle the government sets out (p6 of the draft) is:

> *Every inhabitant of the Republic of South Africa has the reasonable right to aspire to live, work and relax in a safe, productive, healthy and aesthetically and culturally acceptable environment* ***in as far as this is compatible with economic growth****. [Emphasis added]*

In a similar vein, the draft (p5) states that:

> ***In so far as it is reasonably applicable in the South African context*** *[emphasis added] the government endorses the 27 Principles of the Rio Declaration as adopted at the United Nations Conference on the Environment and Development (Rio, June 3 to 14, 1992).*

Both these statements imply a prior judgement that all activities which can contribute to economic growth will automatically take precedence over environmental concerns. This is an unsophisticated, and potentially harmful, policy stance in the long term. In this light we were concerned to learn that the Chief Directorate for Environmental Conservation has no economists on staff. A major challenge to sustainable development is devising acceptable means to assess the economic importance of environmental decisions - something not attempted today in South Africa.

In order to contribute to informed public debate on the future directions of Environmental Policy, we reproduced earlier in this report the 27 Principles of the Rio Declaration.[34] We believe a new government should reconsider South Africa's commitment to the concepts of "sustainable development" for all of its population. It should then make more appropriate institutional arrangements than are at present contemplated.

Commentary on some Key Issues

Accountability

One of the many concerns raised frequently by members of the Democratic Movement, was whether a future government would have the necessary means to ensure that the institutions of the state's S&T system are fully accountable to government for their policies and programmes.

In the short term, the key power government has, is the power to appoint ministers of departments, and to appoint members of boards of governors for statutory bodies. Since much of South African scientific activity occurs in various statutory councils and parastatal agencies, the methods of appointing board members, and ensuring that appointees fully understand their powers and responsibilities, will be important.

It is an anomaly, in world terms, that appointments to statutory boards are not staggered. In South Africa, all terms of membership expire simultaneously. However, this anomaly will provide an interim government with the opportunity to reshape boards without having to request the resignation of existing board members.

We believe board membership for any institution should, in aggregate, reflect the needs of the groups in society which the institution is designed to serve, and the competencies which the institution will need to achieve its objectives. As an example, the current CSIR board is well suited to interpreting the needs of large-scale industry in South Africa, but has no representation of two other significant groups whom CSIR is mandated to serve - SMEs and disadvantaged communities.

Once members are appointed, they must be well briefed on the powers appropriately exercised by boards - as distinct from those which should be the prerogative of management. The international donor community could be helpful to the Democratic Movement by offering training courses or study visits designed to show potential board appointees how well-functioning boards operate.

In much contemporary management thinking, the board's most important function is described as being that of hiring and firing senior management. This power, formally delegated to the boards of the statutory council, is a power which must be seen to be exercised in the interests of all South Africans. Future searches for council presidents must be seen to be

diligent in the examination of candidates, both female and male, from all racial groups; where an international search is decided upon, the time provided for that search must be adequate to make the search a real one.

In modern organisations, the chief executive has a set of agreed-upon annual and long-term goals which have been negotiated with the relevant board. Success in fulfilling them is a trigger for rewards, failure to attain them to the board's satisfaction is an accepted reason for dismissal.

Affirmative Action Programmes

The Democratic Movement believes it is crucial that South Africa is transformed into a non-racist, non-sexist society. The Mission asked each of the institutions we visited - both those involved in education and training and those which were not - about their affirmative action programmes.

Many whom we met explained the poor representation of black people in South African research institutions as the result of lack of supply - which is a fact, given apartheid. They then often argued that the support of excellence is incompatible with action to remedy past injustices. We do not accept this argument as being valid. A future South Africa is not looking only for a somewhat bigger sprinkling of black or female faces in an otherwise unchanged institutional landscape; it will wish to see its institutions, including those of the research system, become fully reflective of the diversity of the country's population. The debate should shift from whether or not this is feasible, towards consideration of a timescale for making acceptable progress - in the light of the magnitude of the problem and the availability of resources of all kinds.

We have heard frequent references to private sector competition for qualified black candidates for professional positions and to the high salaries which such candidates command. However, this evidence was anecdotal, as we are not aware of any survey carried out on the supply and demand for qualified black citizens.

The picture of existing programmes which emerges, is a picture of highly fragmented efforts. There is clearly no effective leadership emanating from the present government or its civil service:

- The universities are divided. Some are putting in place useful programmes to permit disadvantaged students to better prepare themselves for a university education. Others have reacted negatively to a feared future loss of resources in favour of remedial action to strengthen the "historically black" universities.

- The FRD has begun a promising initiative, its University Development Programme. This is approaching, head on, some of the weaknesses of the historically black universities, but despite its early growth rate, it is still small in relation to the magnitude of the problem (its planned R5.5-million budget for 1993 will be about one eighth of the budget of the National Accelerator Centre which is also administered by FRD). No other statutory council with an "agency function" for the support of academic science has developed a comparable initiative.

- The other statutory councils each have affirmative action programmes with respect to their hiring practices. Some, such as CSIR and MINTEK, have small programmes designed to upgrade the skills of black school children to the point where they can proceed to a university or a technikon. One encouraging initiative by MINTEK's senior management is an attempt to persuade the companies with which MINTEK cooperates to replicate the MINTEK initiative. If the target of having 500 companies join the scheme in the next year is met, this will rank as one of the largest initiatives of which we are aware. But even this pales beside the magnitude of the problem of upgrading the skills, particularly in maths, science and language, of the vast majority of blacks in the school system.

- The professional scientific, engineering and technological societies, via their coordinating bodies; Associated Scientific and Technical Societies (AS&TS), South African Engineering Association (SAVI) and Joint Committee of Scientific Societies (JCSS), are actively forging a coalition of forces to tackle the twin problems of affirmative action and a significant improvement in the overall level of teaching and training in mathematics, science and engineering. In one document provided to the Mission[35] they listed forty separate programmes aimed at enhancing the teaching of science and mathematics, some sponsored by industrial enterprises, some by educational institutions, some by foundations. However, there was no indication of the scale of individual programmes, nor any evidence of a mechanism for their coordination

- The picture we have received of actions in the private sector is similarly haphazard and fragmented.

We can only conclude that currently, there are no programmes or policies to encourage affirmative action which are commensurate with the magnitude of the problem. While the majority of the population are realistic enough to know that the pattern of employment will not change overnight in a democratic South Africa, they have every right to expect that the problem will be treated as a high national priority. Our comments on higher education, elsewhere in this report, are pertinent to this issue.

Research for Disadvantaged Groups

Most of the institutions we visited told of their plans to reorient programmes to "meet the needs of the community". Nonetheless, we were left with the clear impression that the individual groups really had little concept of the processes involved in trying to bring about positive technical change in the lives of poor, disadvantaged populations. Both South Africa's imposed isolation, and an abiding predisposition of many South African researchers to look only to the industrialised world for inspiration, has meant that there has been little, if any, exposure to the ways technological development is being supported in a variety of parts of the Third World.

Three important features of research relating to the disadvantaged have emerged:

- a recognition of the need to develop effective means of consultation with those groups whose lives the researchers wish to help improve. This is not a simple process, given the substantial cultural differences which almost invariably exist between the members of the disadvantaged community and the highly trained researcher;
- the requirement that strong emphasis be placed on understanding the social aspects of a community before planning any technological intervention. Successful research activities on poverty require substantial time to develop truly interdisciplinary approaches - this would facilitate an accurate assessment of needs and the translation of those needs into technological research objectives; and
- the need to convert the "needs" of the disadvantaged into "demands" on the research system through a variety of funding mechanisms.

South Africa has a strong capacity for technological development in the statutory councils and in the universities. However, this capacity is linked neither to a social science capacity of any meaningful size, nor to a consultative tradition which would allow communities to have a real say in the directions of research. On the other hand, there are a number of small social science groups allied to the Democratic Movement, with good contacts and credentials in disadvantaged communities. These groups have neither links to, nor influence over, the groups engaged in technological development. Companies operating in sophisticated markets have long since learned the value of market research as a factor in determining research strategy; organisations getting into "community research" should take that lesson to heart.

Research and the Democratic Movement

There are a growing number of research groups and research centres which actively support the different elements of the Democratic Movement. They share a few common features:

- they are almost all in the social sciences (education, economics, urban planning) with a few in the field of health;
- they are highly committed to having their research be relevant to the definition of policy alternatives for a new South Africa;
- they often have good contacts with "grassroots" organisations (in this they are similar to a long-standing tradition in Latin America which has many NGO's and not-for-profit research institutes closely allied to grassroots organisations of the disadvantaged); and
- they are dependent on funding from external donor agencies which support the Democratic Movement as it seeks to bring about fundamental change in the political life of the country. However, once a democratic government is installed, external donors will probably revert to their normal modes of operation - dealing directly with government. It will be important, for the longer term flourishing of civil society, that a new government look sympathetically on the need for many of these groups to survive.

Even where there is some form of coordination, as for example under the National Education Policy Initiative, their reliance on individual initiatives in defining research topics may leave some important issues untouched. In other fields, rather than coordination, there are vigorous disputes. During interim government rule, the Democratic Movement should pressure this body into maximising its contribution and help to define viable policy alternatives.

Just as a democratic South Africa will have much experience, based on the work of groups related to the Democratic Movement, to share with other African countries on linking policy-research to policy-making, there are good examples, elsewhere in Africa, where networks of researchers have been empowered to participate actively in policy-relevant research.[36] A democratic South Africa should seek to participate in such useful, regional activities.

Military Research

We collected no data, and only scattered comment, on the state of military research in South Africa. It is widely assumed, within the Democratic

Movement, that until recently, military research was well funded and was technologically sophisticated. An ARMSCOR-organised Military Trade Fair, held while we were in South Africa, was attempting to convince international buyers that this was the case! We did hear of significant reductions in both funding and staffing of military R&D in recent financial years. However, the relevant data is not in the public domain. Among other things, it would have been useful to know where the displaced personnel were finally relocated. Given their training, they could help in upgrading the technological performance of civilian industry.

Of considerable concern to the Democratic Movement and to the international community, are persistent fears that South Africa was intent on developing a nuclear weapons capability. It is a subject of some concern that a noted international journal of the nuclear industry, *Nuclear Fuel*,[37] has published an estimate that South Africa has already produced about 400 kg of highly enriched uranium, an amount sufficient for about twenty nuclear devices. The recent signing by South Africa of the Nuclear Non-Proliferation Treaty, and the concomitant acceptance of inspections by the International Atomic Energy Authority, is a welcome step towards dispelling fears of the directions of military policy.

It is clear that a new, democratic government in South Africa will wish to conduct a prompt and thorough review of the directions being pursued in military and space research, to ensure that they are consistent with the needs of the new South Africa.

Some Important Policy Issues

In this Chapter, we address a series of additional policy issues which we believe should be considered carefully.

Priorities for Strategic Research

Since no country can afford to be the world leader in all branches of science, choices have to be made. In recent years, countries and organisations have developed sophisticated techniques to help them determine research priorities. These techniques usually involve some combination of knowledge about the most promising research areas in scientific disciplines, together with an identification of societal needs.

These techniques, termed research foresight techniques, have been used to identify national priorities for long-term (15 years) strategic research. They have helped identify those areas of basic scientific research most likely to benefit society within the specified time frame. Other studies have helped determine the most promising areas in which to concentrate resources, within specific sectors or scientific disciplines. Martin & Irvine have summarised the research foresight approaches followed in a number of industrialised countries and corporations. Their book[38] *Research Foresight: Priority Setting in Science* provides a handbook of approaches which could be adapted to South African conditions.

The Japanese have done most to develop these methodologies, and they have had considerable success in "breeding" new technologies through the process of identifying priorities. Indeed, it is the process itself which has proved to be most significant. The Japanese government has articulated a process of involving many scientists, industrialists and policy makers from government, industry and academia in a variety of delphi-type exercises. Such a process of participation helps unite all parts of the scientific and technological communities to work together to achieve the objectives within the agreed priority areas.

South Africa might embark on a similar participatory exercise, involving not only the scientific community, but all parts of society, in an exercise which joins an identification of scientific opportunities with an identification of societal needs. A truly national exercise to identify priorities for strategic research could be a powerful tool in forging a democratic South Africa.

Fundamental Research

Most countries have a Science Policy which includes a policy for the support of fundamental or basic research. Although there is debate on the definition of fundamental research, it is usually taken to mean the research undertaken to satisfy curiosity about nature. It is sometimes called "blue sky" research and is not undertaken to meet direct economic objectives. Any research which is unlikely to be exploitable within, say, 20 years, is frequently referred to as fundamental.

Governments of the industrialised countries, and a small number of developing countries such as India, support fundamental research for a number of reasons. First, because it is a creative activity, and just as governments support creativity in the arts, so too do they support creativity in science. This is a cultural reason. Secondly, by supporting fundamental research in universities, it is possible to train the next generation of researchers. By participating in this type of research, it is argued, students develop research skills which make them more versatile researchers than if they had learned these skills by doing more applied work. Thirdly, since fundamental research has no immediate commercial value the results are published and become internationally available. Scientists doing fundamental research in one country are thus well connected with scientists in other countries. This makes it easy to tap into the world store house of scientific knowledge. But without a local capability, it would be difficult for any country to access this knowledge.

There are no objective guide-lines to suggest how much a country should spend on fundamental science. In the end, it is largely a political decision based on how much the country can afford. It is sometimes suggested that a country should spend as much on this type of science as it does in supporting the arts. In many countries, the amount averages about 10% of the total government R&D budget.

Since this type of research, by definition, has no immediate commercial value, it should be left to the scientific community to organise and to dispense the resources allocated, without any justification in terms of economic relevance.

Only the new government in South Africa can decide how much of the state funded research budget should be set aside for fundamental research, and how those funds should be allocated. There are no guide-lines, other than to suggest international comparison, and for there to be debate about the value to be placed on creativity in the sciences as a cultural activity.

An issue in the financing of fundamental research, which a number of interviewees raised with the Mission, was that related to the financing of the National Accelerator Centre, currently administered by FRD. This laboratory had a parliamentary grant of R28.8-million for fiscal year 1992-93, i.e., an amount almost equal to that budgeted for the FRD's Core Programme which supports university research in the natural sciences and engineering. (The budget of R39.9-million cited earlier includes R10.4-million accumulated in earlier years for the purpose of completing the construction phase of the facility, and an estimated R0.7-million in revenue from the sale of isotopes.)

The NAC is an expensive facility designed for four purposes - nuclear physics research, medical research related to neutron and proton beam therapy for certain classes of cancers, and the production of radioisotopes for medical use. No-one we met, outside those directly involved in the NAC programme, supported or justified a continued draining of scarce R&D funds into this project - the Mission agrees with this criticism. Nuclear physics is an expensive area of pure science which many industrialised countries have difficulty supporting. No country with the huge educational backlog faced by South Africa should perpetuate this misallocation of very scarce resources.

The medical justifications presented as the primary reason for continued funding of the NAC do not withstand scrutiny from any reasonable public health perspective, given the costs involved. South Africa faces enormous challenges in attempting to improve the health status of its poor majority. A future government which reallocated the NAC's budget to other, more socially relevant, research would risk criticism from only a very small minority of South Africans.

International Collaboration in Science and Technology

South Africa contributes less than 1% to world science and technology. It needs to be able to draw on, and benefit from, the other 99%. There are several ways in which this can be done, and the government can play a greater or lesser role in fostering this process. Also, by participating in international collaborative activities, South African scientists can influence the research agenda of parts of the non-South African components of world science.

Governments encourage their scientists and technologists to collaborate internationally for a variety of reasons. These may be scientific, technological, economic or political. In addition to involvement in government sponsored or financed collaborative schemes, many scientists are

also involved in collaborations with colleagues in other countries in a variety of informal ways.

Industrial enterprises have also found it necessary to be involved with foreign enterprises, government laboratories and universities, in a wide variety of collaborative schemes. Some of these are encouraged and financially subsidised by governments and international organisations. International collaboration in S&T has grown in volume and importance over the last decade, and most industrialised countries have developed policies and mechanisms to encourage it.

During this period South Africa has largely been isolated from these developments. In our view, it must become a priority for the new government to encourage South African scientists and technologists to participate fully in new collaborative ventures with foreign institutions. In the past, collaboration was principally directed to First World institutions. In future, collaboration must be linked to some of the innovative Third World networks - such as the international agricultural institutes which are a part of the CGIAR (Consultative Group International Agricultural Research). Equally, it will be important to see South Africans elected to membership in the African Academy of Sciences, and to see young South African scholars participate in some of the Academy's Programmes - such as those on capacity building in forestry research or in soil and water management. Of particular importance would be South African participation in the Academy's Programme on research priorities for the education of girls and women in Africa.

Science and Technology Policy Research

In order to make wise choices and decisions about how to utilise science and technology most effectively to meet society's needs, it is necessary to have access to the relevant knowledge. Since each country is unique, it needs its own S&T Policy research capability.

In South Africa, we found expertise in this area within the programme on evaluation and policy of the FRD, and the new technology policy group recently established within CSIR. We identified no formal S&T Policy research group at any South African university, although we met individual academics with a strong interest in the subject operating from departments at the University of Witwatersrand, University of Cape Town, and the University of the Western Cape.

In our view, it is important that South African institutions strengthen their capacity in this area. They must be able to tap into the international

knowledge base in this field, develop local knowledge, and make the relevant knowledge available to decision makers throughout South Africa. This means there should be a network of research groups able to provide a contract research service, and some academic groups who can train both S&T Policy analysts and policy researchers. These groups might also be encouraged to develop an assessment capability which could be drawn upon for technology assessment and research foresight expertise.

Technology Missions

Some countries have found it useful to define a social objective which requires a major technological input, and then to mobilise all necessary resources to achieve that objective within a specified time frame. This process is called a technology mission. The process whereby the United States put a man on the moon by the end of the 1970's was a technology mission.

The Indian government have defined a number of missions which benefit disadvantaged, largely rural communities, in India. These include the provision of clean water, access to telephones, and the attainment of literacy targets, each within a specified time. To achieve these objectives, appropriate technologies have to be identified and developed, and resources mobilised. These resources are financial and human. They may involve private sector involvement as well as public sector financing. They require the combined efforts of many people, including voluntary agencies, in a major national endeavour.[39]

The new South Africa will have a need for similar technology missions. These could relate to housing or electrification, water, sanitation, education, etc. It would be valuable for the new South Africa to identify a few social objectives for which technology missions might be designed.

Promoting Debate on Policy Options

This report is only a first contribution to a public debate on future directions for S&T Policy for South Africa under a fully democratic government. We agree with our sponsors in the Democratic Movement that such an exercise is important. The process will start when we, the authors, return to debate our conclusions in public, both with representatives of the Democratic Movement and with representatives of the institutions we discuss.

We believe that the National Economic Forum is a promising new locus for discussions on the future directions of South Africa's formal economic sector. We hope participants would consider establishing a space in the forum's agenda for some detailed discussion of technology policy in general, and on some technological initiatives which might become vehicles for revitalising important sectors of South African industry. South Africa has a great need to focus on developing employment-intensive technological strategies. The needs of the informal sector in the South African economy must also be explored.

For a truly national discussion of S&T Policy to ensue, there must be initiatives from many quarters. We expect that the ANC, COSATU and SANCO will see to it that their members have the opportunity to express their views. We also invite the various scientific and professional societies of all disciplines to initiate within their memberships discussions on S&T Policy. Hopefully, the documentation emerging from this review will provide a starting point for debate. However, the challenge will be to define a process which allows South Africans from all backgrounds to discuss the issues embodied in S&T Policy - whether they be from the Democratic Movement, from the social, natural or health sciences, from employers' groups, government or unions. If the ANC, COSATU and SANCO are able to follow through successfully in their intention to promote such a wide-ranging debate, they will have made a significant contribution to showing the way towards promoting a participatory form of democracy for the country.

An Important Issue to Address in the Short Term

The Democratic Movement supports a deliberately participatory form of government, and is committed to the promotion of wide public discussion of future policy options. Given this orientation, which we fully support, there is one particularly pressing issue which needs careful consideration, assessment and debate. That issue is the future structure of the tertiary education system, and the definition of its roles in teaching, research and community service.

We have sketched some of the dimensions of the problem: disparities in performance; lack of clarity in the roles to be played by different kinds of institutions; the need to deal with poorly prepared students; and so forth.

It would be a signal contribution of the Democratic Movement if it were to initiate a process of wide consultation around the development of policy options in this field for a future government. We are aware that there has been a proposal to establish a National Education Negotiating Forum, whose terms of reference and agenda, once agreed upon, will cover a much wider domain than that of tertiary education alone.

A central question is how such wide consultation might be mobilised, and the Democratic Movement must develop a clear proposal. One option, which would parallel a process frequently used in other democratic societies, would be the appointment of a non-partisan independent commission of enquiry into the tertiary education system. Such a commission would need to have:

- a set of commissioners who, by dint of their origins and accomplishments, would command wide respect throughout South Africa;
- a clear set of terms of reference and an acceptable time frame within which to report;
- the power to hold public hearings, to invite submissions, and to conduct studies and research if necessary;
- the requirement to make public their findings, any testimony which they gathered, and the results of any research which they commissioned; (a well conducted commission could set new standards for transparency in its operations);
- a competent, professional secretariat; and
- an adequate budget. (The Mission believes that such a commission would be of considerable interest to the donor community and that a consortium of external donors could almost certainly be assembled. What would be very encouraging, however, would be the appearance of any South African group willing to contribute funds while imposing no conditions beyond the normal demands of financial probity.)

Clearly, this is only one option; we have not had the time to explore, for example, the pros and cons of the creation of a national forum on tertiary education as an alternative.

Whatever structural option might finally be chosen, its legitimacy will depend on the openness of its proceedings, the transparency of its processes and the perceived quality and representativeness of the group of people charged with carrying out the task.

Appendices & Notes

Appendix 1:

Membership of the Mission

The following were members of the Mission:

Leader:

Mr James Mullin (Canada),
Consultant, S&T Policy; Former Chairman, OECD Committee on Science and Technology Policy.

Members:

Dr Deanna Ashley (Jamaica)
Principal Medical Officer, Secondary and Tertiary Care, Ministry of Health, Jamaica.

Dr Lydia Makhubu (Swaziland),
Vice Chancellor, University of Swaziland.

Dr Thomas Odhiambo (Kenya),
Director, The International Centre of Insect Physiology and Ecology, (ICIPE), Nairobi and President, African Academy of Sciences.

Professor Geoffrey Oldham, CBE (United Kingdom),
Science and Technology Advisor to the President, International Development Research Centre, and Former Director, Science Policy Research Unit, University of Sussex.

The international members of the Mission take full responsibility for the ideas, analyses and opinions expressed in this report.

Appendix 2:

South African Participants in the Mission

The Mission's work was helped immeasurably by the participation of a series of South Africans, each of whom participated in some of the Mission's formal meetings, and who assisted the international members in placing events, organisations and personalities in a South African context. Those participants were:

Dr Ivy Matsepe-Casaburri,
Executive Director, Education Trust for South Africa.

Dr Jairam Reddy,
Vice Chancellor, University of Durban-Westville.

Dr Jakes Gerwel,
Vice-Chancellor, University of Western Cape

Dr Frene Ginwala,
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Appendix 3:

The Mission's Schedule of Meetings

Date		Morning	Afternoon
Sunday	Nov 15		Mission Meeting
Monday	Nov 16	Democratic Movement	Department of National Education and the Scientific Advisory Council
Tuesday	Nov 17	Foundation for Research Development	South African Bureau of Standards
Wednesday	Nov 18	Council for Scientific and Industrial Research	CSIR (cont'd) and Committee of University Principals
Thursday	Nov 19	Human Sciences Research Council	Department of the Environment
			Evening: President of the ANC
Friday	Nov 20	Professional Associations	Parastatal Enterprises - ESKOM and the AEC
Saturday	Nov 21	Democratic Movement Research Groups	Democratic Movement (cont'd)
Sunday	Nov 22	Mission Meeting	
Monday	Nov 23	Agricultural Research Council	Department of Trade and Industry
			Evening: SANCO
Tuesday, (Group 1)	Nov 24	Medical Research Council	Committee of Technikon Principals
(Group 2)		Universities from southern part of SA	Universities (cont'd)
Wednesday	Nov 25	Universities from northern part of SA	South African Chamber of Business
Thursday	Nov 26	Council for Mineral Technology	The Development Bank of South Africa
Friday	Nov 27	COSATU	Mission Meeting

Appendix 4:

Minutes of Public Meetings

Meeting with Representatives of Organisations Affiliated with the Democratic Movement

Johannesburg, March 4 1992

In the Chair:	**Sir Herman Bondi**, United Kingdom, Chairman of the Board, International Federation of Institutes of Advanced Study.
Mission Members:	**Mr James Mullin**, Canada, Mission Leader; **Dr Deanna Ashley**, Jamaica; **Dr Geoffrey Oldham CBE**, United Kingdom
	SA Members of Mission: **Dr Frene Ginwala**, ANC Research Department; **Dr David Kaplan**, University of Cape Town; **Dr Ivy Matsepe-Casaburri**, Education Trust for South Africa.

Representatives from:

ANC	(Research Department, Department of Education, Department of Economic Planning)
COSATU	Congress of South African Trade Unions
SANCO	South African National Civics Organisation
ANC	Science & Technology Group
CASE	Community Agency for Social Enquiry
CDITP	Centre for Development of Information and Telecommunications Policy
CHESS	Centre for Health and Social Services
CORE	Cooperative for Research and Education
COSATU/CWIU	Chemical Workers Industrial Union
COSATU/NUMSA	National Union of Metal Workers of SA
EDA	Environmental Development Agency
EDRU	Energy for Development Research Unit
EDT	Education Development Trust
EMG	Environmental Monitoring Group
EPDU	Education Policy Development Unit
EPU at UWC	Education Policy Unit at UWC
EPU Natal	Education Policy Unit (Natal)

EPU at Wits	Education Policy Unit at Wits
ET	Economic Trends Group
GEM	Group for Environmental Monitoring
HSRT	Health Systems Research Trust
ISP	Industrial Strategy Project
IUPHC	Institute for Urban Primary Health Care
MERG	Macro-Economic Research Group
MRG	Military Research Group
NGRN	Natal Gender Research Network
NEPI	National Education Policy Investigation
NLC	National Land Committee
NPAI	New Public Administration Initiative
PPHCN	Progressive Primary Health Care Network
RAC	Rural Advice Centre
SAHSSO	SA Health and Social Services Organisation
UDUSA	Union of Democratic University Staff Associations
USN	Urban Sector Network

Morning Session

The Chair Welcomed all those present and extended apologies for Lydia Makhubu and Thomas Odhiambo, two members of the Mission unable to participate in the final meetings.

SANCO The representative of SANCO delivered a prepared statement of SANCO's views on S&T Policy.

SANCO have conducted their own review of S&T needs for disadvantaged communities and some of these are:

1. Improved techniques for excavation - there is a need for improved engineering services, as opposed to R&D, for building much needed dams, bridges and rural roads.

2. South Africa should look at availability of international personnel and at the role ESKOM is playing in its overall development.

3. An overall goal has to be improving the quality of life and development in general. Electrification and housing should be addressed in particular.

4. Education in general needs to be addressed and action taken to improve the system, particularly for black people. In 1988 the total schooling success rate for black students was only 3%, because of the country's political system. Institutions should devote greater attention to training of their work force.

5. There is a 40% unemployment rate which does not say much for current economic or S&T Policy.

SANCO argues that policy should assist in increasing the number of development projects addressing the people's needs, and that people in the country need to be part and parcel of the development process.

SANCO also questioned the emphasis on big industrial development for exports, instead of concentrating on

local developments. SANCO felt that development policy, and with it S&T Policy, needed to be reformulated.

Because of lack of education, people are regarded as incapable and are excluded from the process of development.

SANCO would argue that it was questionable whether any government could give effect to a useful S&T Policy unless other relevant issues, which were more important in people's lives, were taken into account; S&T Policy must relate to other policies.

EPDU

EPDU felt it was good that the Mission's findings were to be open to the larger community. They said there were many issues for discussion.

It is a mistake to represent the Mission report as initiating a policy debate. This was done some time before. In 1990 the ANC held a national conference and discussed the same issues. In 1992, the ANC adopted S&T guide-lines, but no mention of the ANC report was made.

Also, the report makes no reference to the considerable amount of work already done in the tertiary education field. Evidently, the Mission did not want to go over the same ground.

The Mission

While the Mission acknowledged that debate on S&T Policy had begun within the Democratic Movement before initiation of the present process, it would be wrong to believe that the Mission's report was in any way a final word on the complex issues involved. Rather, it was designed to interject a series of important questions into the public domain, within a fairly comprehensive framework.

ANC S&T Group

The overall report covered many areas quite well but a large omission was made, i.e., the Mission did not mention water research and the role of the Water Research Commission.

There is a substantial need for water and sanitation in various communities. This issue is different from other issues on the agenda because of lack of private funding.

An additional area of concern which needs fuller treatment is the unilateral restructuring of research. This issue is not sufficiently stressed; the move towards non-state funding of the councils makes the councils independent, and able to remain unaffected by changes in the longer term.

COSATU COSATU welcomed the report, which is best looked at as a survey of what is now happening in S&T. COSATU also felt that the debate and outcome should be made public, as a means of informing a wider public about what S&T Policy is all about.

An important requirement for COSATU was getting the S&T Policy process speeded up, as the research institutions in government are currently moving to restructure themselves.

EDRU Research funded by government departments is not mentioned in the report. There should be an effort to speed up dissemination of the results of the Mission's enquiry.

NGRN The report is gender blind. Attention needs to be paid to technology which is appropriate with respect to gender issues.

Debate on the "Issues for Discussion"

Decision-making and Resource Allocation

The Mission There are many issues to be faced by an interim government which, it is to be hoped, will wish to use S&T as an important tool in the achievement of its goals. That interim government will have to cope with very severe resource constraints, since the list of basic needs to be addressed is very long. The Mission has tried to set out a series of questions which South Africa

will need to resolve as it reorganises its governmental structures.

ANC Regarding the question of ministerial authority for S&T Policy, what range of options does international experience point to?

The Mission The experience varies both from country to country and, with time, within the same country. The UK has traditionally not had a Minister for Science while the French and German governments tend always to have a portfolio for S&T. However, recently the UK has had a minister charged with looking at the health of science in that country.

In most countries, responsibility for R&D is spread through the appropriate sectoral ministries, such as agriculture, energy, and environment. The issue is whether or not there should be a single minister responsible for the development of policy for science, for technology, or for both.

Among the key lessons to be drawn from international experience are the following:

- The head of government's concern and interest for S&T is essential; and

- It is often useful to have a senior minister in cabinet charged with ensuring the development and application of S&T Policy; this need not imply a separate department or ministry; what is more important is that the person holding responsibility be a member of the cabinet's key economic and social committees, to bring about policy integration. In Canada, such ministers have often held other senior portfolios concurrent with the responsibility for S&T Policy.

The Chair The history of S&T in France is of interest - with few changes in structures, the fate of S&T varied according to the President's interest in the matter. Two presidents, De Gaulle and Giscard D'Estaing, believed in the importance of national S&T efforts and, as a

consequence, S&T prospered while they were in office. The present French government, under President Mitterand, is not particularly interested in S&T.

CHESS

On the issue of the orientation of the statutory councils - how do we disentangle the institutions from the entrenched apartheid policy?

Under the present government, S&T has been kept subordinate to the overall political objectives of the National Party. What will be involved in reorienting these institutions towards work on the basic needs of the population?

IUPHC

Views differ with regard to the health sector - the influence of a minister or president is much less important at the local level, which is critical to health research. Services need to be locally accountable and as locally based as possible.

SANCO

Japan suggests a different direction. There the minister is merely a co-ordinator and it is not the function of government to determine priorities. Instead intense debate involving all stake-holders is used to determine priorities.

RAC

Two points of concern:

a) The debate on research needs to link the economic with the environmental debate; and

b) Access to information - a future government must ensure dissemination of research results.

EPU at UWC

The discussion would benefit from the knowledge and experience of the Mission on policy guide-lines with respect to two issues:

a) What kind of experience is there concerning mechanisms for decision-making in the field of research policy, combining internal expertise and input by external stake-holders?
b) What can be done to enhance the role of research in decision-making generally?

The Mission

On international experience and procedure for advisory groups - whether to advise ministers or departments:

- membership is often by appointment by the prime minister, so political judgement is involved;
- the extent to which the advice of a committee is made public varies from country to country;
- currently in the UK, 50% of the advice is confidential to the prime minister, and 50% is published. The private advice which is not published is often treated seriously by the prime minister;
- Canada and Australia always publish results of advice formulated by advisory boards, primarily as a contribution to informed public debate;
- in most cases - when a top body intervenes in an issue - governments publish results;
- advisory mechanisms on lower levels than reporting directly to the head of government can make useful contributions; for example, the Japanese case of widely consultative mechanisms to advise on likely emerging technological trends. The value of the Japanese process is the way in which the consultations bring shareholders together.

ANC

A recent newspaper editorial advocated that science policy should come from a politically neutral body - what would the Mission's reaction to this be? South Africa today is a very political society - rapid change is coming in the direction of removing racial barriers. Is it unreasonable for government to set national goals and priorities for research?

The Mission

The Mission does not agree with those who see policy advice as "non-political". Politics is the process of allocation of public resources and S&T Policy seeks to allocate some of those resources in particular ways.

For example, the allocation of funds to the National Accelerator Centre for cancer research was an intensely political decision, given the competition for public resources for both R&D and for health.

The appropriate role for ministers is to articulate goals towards whose achievement public funds are to be expended. Having set out a resource allocation, ministers can then seek technical advice on how best to approach the goals within those resource constraints.

COSATU

There is a need for organisations to stimulate their constituencies - it is clear that S&T Policy cannot be left only in the hands of a future government. What we can learn from other countries and what we need from the international experience represented by the Mission is not a model but knowledge of the unforeseen consequences of other countries' decisions and experiences.

The Chair

In summing up the discussion of decision-making systems, the chair recognised the enormous pressures a new government will face as it tries to reconcile the limitations of the resources at its disposal with the great range of pressing needs.

He touched on the problems of the roles which could be played by existing public servants - i.e. those who served under apartheid - under a democratically elected government. He saw South Africa as needing many of their talents but insisted that those talents would have to be at the service of the policy goals and objectives established by a new government. This view might apply to most public servants except for a few, whose continuation in public office would be an offence to the majority of the population.

He recognised that the huge rifts within South African society will not be healed overnight, but that in the long term, with South Africa reintegrated into the world system, the prospects for all South Africans should be bright.

On the narrower questions of how to organise high-level decision-making, specifically related to science and technology, he had been impressed by the depth of thought which had marked many of the interventions.

He saw great challenges involved in dealing with the problems of the majority, and hoped that a democratic South Africa would be able to channel its scientific and technological competence towards solutions to many of the economic and social issues facing the country.

Focusing on the Problems of the Majority

The Mission

As outsiders, it is not difficult to see that, in the past, South Africa's S&T had been applied, with success, to making white South Africa a prosperous, well-developed society. Today's challenge is to begin the long journey towards the time when all South Africans will enjoy acceptable living standards, and in which all communities will be able to have the fruits of scientific and technological activities deployed on their behalf.

The great tasks ahead are to devise ways for communities to formulate and express their needs and wishes, and to find ways of giving communities access to the resources which will turn their felt needs into effective demands (in the economic sense of the term).

While there are many specific lessons to be learned from communities elsewhere in the Third World. It is of primary importance for South Africans to devise their own ways of tackling their problems.

EDRU

Many of South African society's needs - such as for improved housing, electrification, or improved water supply - are very obvious. What is more difficult is the design of practical responses to those needs.

Two important issues are the following:

a) those most closely involved in interpreting the research needs of the majority have depended on money from abroad. We should think strategically

about integrating NGOs more fully into the system, once a new government is installed; and

b) funding is the primary mechanism for re-orienting research foci and for establishing broad priorities. The way in which funding bodies operate in a new South Africa will be crucial.

CDITP

It is essential to understand the authority behind any policy on the problems of the majority. If the process of formulating policy is not acceptable, the policy which flows from such a process will also be unacceptable.

S&T Policy is political and must be linked to other policies developed by appropriate, democratic policy processes. Many current South African policy-making structures are not acceptable, in their present forms, to the majority. However, when policies are appropriately developed, they can yield substantial results. The speaker, who had received some of her university education in Cuba, referred to Cuba's impressive competence in medical research, and to the fact that the majority of Cuban engineers and technologists were women - a vastly different situation from that found in South Africa.

South Africa needs to develop a culture of science in the day-to-day life of the population. Today, few blacks can go into S&T because of their low standard of education. There will be a long-term need for bridging programmes, and an emphasis on the quality of primary schooling.

EPU at UWC

How do we reconcile the needs for competent people to evaluate policy with the need to broaden the base? Who makes the decisions?

The report has an emphasis on natural sciences, with a very narrow vision. The social sciences are neglected.

Independent Participant

In this country we put too much emphasis on social science. We lack technology. South Africa doesn't need

more anthropologists; the report is correct in its relative emphasis on technology.

More emphasis needs to be placed on job creation. Present resource allocations provide R60-million per year to the social sciences and they are not worth it; there are too many "party hacks" in the system today. These "party hacks" are funded and are not productive.

Future research projects should be funded by tender, and be for a restricted duration. Scientists found to be unproductive in research should be employed in other areas, such as teaching.

SANCO

Some existing institutions should be restructured. A new government should dismantle or transform such institutions, particularly in the social sciences.

The present government has concentrated too much on arms development, and on preserving secrets. A new consultative process should be set up, to focus attention on "majority problems". Such a process would need to be conceived on a broad basis and interested groups should begin to focus, now, on this point.

CASE

The suggestion on a possible role for NGO's is patronising. They are part of the research system, providing research services to organised constituencies. They are not merely an interface between the system and communities. The question should rather be - how can the monolithic part of the system respond to the smaller, livelier NGO bodies?

EPU at UWC

Looking to the previous topic of debate, and the question of the management councils:

(1) They are treated as homogeneous - is this right? They should be desegregated.

(2) Where are the multi-disciplinary initiatives?

(3) How do policy and the market shape research conducted by the statutory councils?

NLC

The ARC was set up in 1992, turning a government department into a parastatal - now government may try to change it into a private sector operation. Its work is perceived as continuing to serve high-tech large-scale farming, and as an attempt to produce black clones of white farming. There is a need to take a close look at the ARC and if necessary close it down.

NGO's are engaged in development work - universities are only now beginning to think about producing graduates who can do development work.

IUPHC

With respect to the health sector - notice that in the health budget a big chunk is gobbled up by universities! There is no such thing as political neutrality in research but the issue of academic freedom is sensitive. Local communities need the power to buy medical services and thereby determine the direction of research. Medical schools could be obliged to fund themselves.

ANC Research Department

Is there a way of combining the financing of councils through a system of contract research, which in turn is compatible with empowering communities? At present all the councils and universities find that if they do research work for communities, it is generally funded by foreign donors or through parliamentary grants. The communities themselves do not control the funding of work done on their behalf. This question becomes all the more urgent given that much of the foreign funding of NGOs will be redirected when there is a democratic system in place.

The Chair

To summarise some of the points made, and to comment on them -

The Cuban example of reducing sexual biases in career choice, is related to the observation that the world's most powerful contraceptive is the education of women.

Two points need to be made with respect to agricultural research:

1) there is a need for First World research - to maintain food production and export capacity of commercial agriculture; and

2) we have had too little discussion of South Africa's needs in terms of support for small-scale or subsistence agriculture - the role of this sector does not appear to be well documented or understood in South Africa.

In the debate over the social sciences: it is all too easy to overlook the important role that they should play in close association with natural scientists, in programmes of technological development.

In health: perhaps too much money is already going into medical research when health in poorer communities might be more rapidly improved through investments in housing and recreational facilities.

COSATU

South Africa needs to capitalise on its rich resource of activism. The combination of civics, unions, NGO's and mass organisations have the potential to formulate ideas for action.

The practitioners of the natural sciences and those of the social sciences do not understand each other. Equally, the universities need to have healthy interactions with the outside world - this might help to overcome the painfully slow pace at which ideas emerge from universities today.

There are severe problems in assuming that the NGO sector is doing good work. Are they achieving results? There are NGOs which do not deliver. To say that they contribute to S&T automatically is untrue. Some are abysmally unaware of the problems.

ISP

We must look at the reasons for irrelevant research. We should not be afraid to use the power of the market to redirect research. There also must be a redistribution of the power to purchase research. We have strong communities - they can be further strengthened. Our thrust should not be supply push but demand pull. What

might be the consequences of issuing coupons for the purchase of research to communities? Reallocation of monetary power.

ANC

The market is not all that determines research directions - the national research system is ideologically determined. How are we going to use our power to influence research directions in the next few months?

We should get away from a very narrow view of S&T which excludes the social sciences. Internationally both are part of S&T and they can't be separated. We are critical of the fragmented character of the existing research system, but we tend to fall into the same trap.

SANCO

There is a need for co-ordination of different sectors. But the drive needs to come from communities.

The Mission

There is an ongoing debate, in all countries, about how close social scientists should get to government. There are those who see an important role for the social sciences in informing decision-making and in helping in policy formulation. Then there are those who see the role of external social critic as the only appropriate role for the social sciences.

In much research in the developing world, there are good examples of how social research can shape the orientation of research in the natural sciences. For example, social research in Sri Lanka dealing with the resource constraints which conditioned crop selection by marginal rice farmers, led biologists to develop fast maturing varieties of rice which did not depend on expensive chemical inputs. This allowed poor farmers, without access to credit, to increase their annual output by planting and harvesting a third crop each year. In the absence of the social science input, the crop breeders would most likely have continued to concentrate on resource-intensive high-yielding varieties of rice which are preferred by larger farmers.

But there are more problems in having scientists deal with poor populations than just having appropriate social science research built into programmes. One must

overcome the great cultural divides which often exist between researchers and marginal communities. This is often cited as a problem of expatriate researchers in the Third World - but the gaps can apply between researchers and villagers of the same nationality. We might venture to guess that many expatriate researchers working in Africa are more sensitive to the problems which can be created by cultural differences than some South African researchers now on the staff of one or other of the statutory councils would be in relating to a typical township dweller.

The S&T Roles of Higher Education

The Mission

The Mission spent two weeks in South Africa and depended heavily on interviews and written reports. It tried to identify critical issues which a new democratic government will have to face. Mission members did not come to South Africa with vast knowledge of the country.

That said, the Mission is struck by the enormity of the problems facing a new government at all levels in the education system, from primary to secondary to tertiary level.

Higher education has problems of organisation made more difficult by the past designation of historically-white and historically-black institutions.

All of the institutions have weaknesses, but there are also strengths in the system. Changes, some delicate, will be needed. For example, there is the question of academic freedom and its relationship to the choice of research pursued by faculty members; there is a need for a much closer alliance between academics and the rest of society.

Some countries have used a "carrots and sticks" approach to reorient academic research towards contemporary societal issues. In the UK, university research today is much more related to social needs than was the case 10-15 years ago.

The Mission is aware of the large volume of research now being undertaken, particularly by groups allied to the Democratic Movement, on the problems of education, and it is aware of the effort to create a national education forum. However, there is still a need to take a particular look at the multiple roles which the tertiary education system will be expected to play within South Africa's S&T system.

SANCO

There is an absence of S&T in historically black universities. An agricultural student costs R64 000 per year (per person), but an arts student R17 000. There is a skewed distribution of resources.

The predominantly white universities cannot address the imbalance in curriculum to fill the need for a greater "development" orientation.

SAHSSO

In South Africa today we have the irony of what the authorities view as a "surplus" of white school teachers (with large numbers being laid off), because white primary schools are closing. At the same time there is a chronic shortage of qualified teachers in the black school system.

There are great imbalances in the use of funds in the tertiary education system; Wits and UCT students are highly trained at great cost to tax-payers.

There needs to be a redistribution of funds within the education system and South Africans need to ask "who are we producing and for what system?"

Unannounced Speaker

The education system did not produce enough engineers under the apartheid system, much less did it offer adequate opportunities to women. South Africa needs to begin by bringing about a profound change in female schooling.

EPDU

A "Commission of Enquiry" such as that proposed by the Mission would have no teeth. Power over education

rests with the Minister of Finance who uses funds as a stick.

Within the universities today there is no real assessment of the country's needs - people are appointed for their expertise, and then teach and carry out research according to their own interests.

There is a need for mechanisms to identify junior staff for university positions and then to introduce a counterpart system. Younger people must be trained to take positions within universities. South Africa is unlike other countries where those whose positions were being taken over were expatriates leaving the country. Here those to be replaced are South Africans. This is an area where foreign donors could help.

CHESS The question of academic freedom will remain a difficult one. The Democratic Movement is not opposed to basic research, but we do believe that the public and tax-payers have a right to expect that the needs of South African society are being addressed.

ANC There are those who would solve the university funding problem by perpetuating the division of responsibility between the historically-black universities (which emphasise their teaching functions) and the historically white universities (as sources of research and of advice to governments). Given limited resources, should a democratic South Africa consider having some universities which are purely "teaching universities"?

The Chair The only country which has succeeded in establishing an array of high quality teaching universities has been the US. Other countries have failed. In Europe there have been notable failures in attempts to create teaching universities without a related research capacity.

COSATU MERG (The Macro-Economic Research Group) attempts to combine research and capacity-building through a network across universities. In practise the (economic and social) development aspects of research tend to be ignored. The older universities can produce research more quickly than newer institutions, but the

idea of "centres of excellence" can be dangerous if seen in the wrong way.

UDUSA Networking is important. There is a need for an integrated approach to tertiary education, taking in all the different kinds of tertiary institutions in a region.

EPU at UWC The question of specialisation of universities is not necessary in the terms raised here. Different universities have different kinds of expertise to network. The central issue is to break through the black/white university stereotypes. If one really wants to restructure, institutions must know what they are capable of doing. We therefore need a set of institutional profiles.

The Chair There is also the question of gender inequality in engineering which can be even greater than racial inequalities.

EPU at UWC The whole issue of gender inequalities is not well appreciated in South Africa. There is a 55% female to 45% male ratio of students today in Standards 9 and 10. There are other huge issues in the education system. A starting point is how to restructure secondary education.

Also, what should become of the unparalleled autonomy of South African universities? Nowhere else in the world are universities as free to go their own way. What should the future be for basic research at each of South Africa's universities?

The real issue is how to restructure the universities, defining levels of necessary quality to be attained by all of the universities.

ANC Most women are channelled to one of two professions - teaching and nursing. We need to break away from this pattern.

The future relationships between the technikons and universities also cannot be ignored - we feel strongly that all of tertiary education must be addressed.

Unidentified Speaker

The concerns about tertiary education are appreciated - but the critical area for concern is lower down, at school level.

CDITP

School maths is not the big issue. The problems for girls in education emerge the higher up you go.

SAHSSO

There are practical problems in trying to rationalise the universities in this country. Whites are not going to black universities. UWC opened its pharmacy school to all groups, but white students preferred to study in the Transvaal. Black universities attract students from homelands and are only 2% white. There is an added complication arising out of the fact that UWC selects proportionally according to race-groups.

COSATU

There is an articulate lobby within the tertiary education system; what is needed is much better government policy. The Democratic Movement needs to think of how it can circumvent the pressures from vested interest groups and force government to address the many issues we have been debating.

NGRN

My heart sinks at the thought of another education commission. The issue needs to be addressed at a much higher level.

The Mission

The Mission was aware of the many studies on education in South Africa, but the goals of the commission which were proposed touch on different issues:

- How can the research done to date be translated into specific policy options which could be acted on by a new government?
- Could such a commission be a vehicle for the promotion of new standards of transparency in the process of formulating policy options?

Science, Technology and International Competitiveness

The Mission

The Mission's report tries to highlight, in its introductory section, the growing world-wide attention being paid to the internationalisation of technological development, the rapidly expanding globalisation of corporate behaviour, and the intense attention being paid, by the governments of industrialised countries, to the promotion of international competitiveness.

It seems of particular importance to highlight the significance of technological innovation as a key characteristic of competitive enterprises and competitive economies.

The Mission has heard much concern expressed about the perceived "privatisation" of some of the statutory councils, but would note that this is a world-wide trend. Many public bodies throughout the industrialised world are now expected to earn significant portions of their income from contracts for their services.

In this global context, it will be important for South Africans to assess the basic competitiveness of South African industries.

The Mission was surprised, during its November meetings, with the lack of attention to the technological performance of small and medium scale enterprises which often are key sources of innovation.

ANC S&T Group

The ISP has long argued that management should recognise worker-innovation as important, and that there should be an adequate reward system for ideas from the shop floor.

COSATU

The unions are breaking down old barriers by talking to workers about new directions for technological change. The unions, more than management, are introducing ideas to the national economic forum to promote improvements in the technological performance of South African industry.

Some of the unions are close to developing a new bargaining strategy which will replace the old idea that collective bargaining, at the end of the day, is just about wages.

ISP

The speaker was unhappy about the section of the report which failed to even mention the draft White Paper on Technology Policy from the Department of Trade and Industry. This is an important oversight since a technology policy is expected to be an important part of an industrial strategy now being developed by the Minister of Finance. There are various aspects of the draft White Paper which needed comment, including the non-transparent way in which it was developed.

The Mission, in its understanding of technological development appears to over-stress innovation and to under-stress incremental technological change.

The report is unfortunately focused on institutions and the elite, such as engineers within enterprises, but what about the role of workers? COSATU has done a great deal of work relevant to this debate but their ideas are not reflected here! Much power is to be found on the shop floor. The whole topic of worker-innovation needs to be explored much more explicitly.

The Mission

The Mission is convinced of the importance of incremental technological change, and believes that study will show that more change is the result of the inputs of creative engineers than of shop floor workers - but this is not to deny the importance of having an innovation-oriented work force in which everyone is on the look-out for improvements.

The Mission did not simply ignore the draft Technology Policy from DTI - we saw a draft, interviewed the newly-appointed responsible officer in the department and came away convinced that there were no innovative ideas about to emerge. We also took into account the protracted period during which the draft had existed without being transformed into real policy proposals. The Department's work on the issue of technology

policy did not seem to be progressing with any sense of urgency or importance.

SANCO

The policy of this country has been to move away from a labour intensive structures towards dependence on machinery. Very little attempt has been made to upgrade the skills of people in the workforce.

The problems of small industry need to be addressed - this is a big gap in current policy! Small industries will be important in addressing social needs and in overcoming urban unemployment.

UDUSA

We must investigate the role the military has played in shaping South Africa's industrial technological capacity, and analyse the effects of sanctions on local industry.

SAHSSO

In the industrialised world, patents can extend to 20 years - how will this affect us in South Africa?

The Mission

The issue of the duration, and more importantly of the effects, of patent protection is widely debated in industrialised countries. Canada, for example, has recently acted to extend the duration of patent protection offered to pharmaceutical products - a move which may have extensive negative effects on the domestic generic drug manufacturing industry. The move was justified in terms of the increases in pharmaceutical R&D which are expected to be stimulated.

The pharmaceutical industry is a difficult one for many national governments to control. It is very powerful and the prices it charges have very significant impacts on the health budgets of many, particularly developing, countries.

ANC

There has been so much secrecy around so much South African industrial activity that it is difficult to evaluate its capacity and its competitiveness. We suspect that imported technologies have been systematically preferred to indigenously-generated ones.

Questions need to be asked about the relevance of a number of large programmes - for example, the present

government seems prepared to spend R5-billion on the development of a capacity to launch satellites!

There needs to be debate on where South African S&T fits, internationally, and on the role of subsidiaries of multinational corporations in our economy.

The Mission There has been study, in the industrialised countries, of the impact of multinationals on domestic S&T capacities. The main conclusion is that multinationals tend to invest in R&D within a particular country in a given field once that country has developed significant strength in that field. The MNC's therefore will act to expand and strengthen existing S&T capacities, rather than act as the sources of entirely new strengths.

Recently, MNC's have shown increased interest in supporting university research groups in countries other than their home country. This is a good opportunity for financing university groups, and potential host countries should look at ways of using such links to give their nationals exposure to the range of technologies being developed by the multinational involved.

ANC S&T Group While South Africa complains of the brain drain to the US, neighbouring countries have the same attitude towards South Africa.

CDITP There is also a brain drain to the private sector. Universities and NGO's can't compete with the salaries that they offer.

The Chair All pressures for affirmative action bring this danger.

ISP The Mission might do well to stress, in its meeting with the system representatives tomorrow, that to date, international links have been exclusively with First World industrial countries. The science councils have very little knowledge of Third World networks.

EDT Affirmative action draws not only South African blacks but blacks from all over Africa.

IUPHC — There is a concern over people [blacks] from outside South Africa with skills, competing with South Africans for jobs.

EPU at Wits — South Africa's main problem is a shortage of highly skilled people. We must try to attract black emigrants back to South Africa. Perhaps we could offer secondment from their institutions with the aid of international funding.

ANC — Blacks from outside South Africa are, and have been, actively recruited to the bantustan universities. As a result, foreign blacks now feel threatened and refuse to appoint or select South African blacks.

The Mission — Incentives to return to work are much better than restrictions from going. The country must create job opportunities.

The Chair — The best hope exists in negotiating with donor agencies to bring South Africans back to South Africa.

CDITP — We need a policy of South Africanisation. People will respond to a clear policy.

The Chair — It is also important for South African blacks to return as role models.

CDITP — Colour is not that much of an issue for role models.

Concluding Statement

ANC — Thanks to the Mission on behalf of ANC, SANCO and COSATU.

For those involved, the experience has been a rapid and intense learning experience. We must take responsibility for some of the omissions from the report. For example, we failed to ensure that the Mission met with institutions like the Central Statistical Service.

Our perspective for the next stage involves the development of a task-force under the umbrella of

ANC/COSATU/SANCO. This task-force would be responsible for a dual process:

(1) policy development; and

(2) engagement with the existing system in the transition in ways that facilitate the re-orientation and transformation of the system in the longer term.

A great deal of attention and energy has been devoted to ensuring that, in this first stage, there was effective consultation amongst the three organisations involved. In the next phase, as we move from research and information-gathering to policy development and engagement, an even broader range of organisations will need to be actively involved.

Meeting with Representatives of South Africa's Existing Science and Technology System

March 5, 1993, Johannesburg

In the Chair:	**Sir Herman Bondi**, Chairman of the Board, International Federation of Institutes of Advanced Study.
Mission Members:	**Mr James Mullin**, Canada, Mission Leader, **Dr Deanna Ashley**, Jamaica, **Dr Geoffrey Oldham**, CBE, United Kingdom.
Participants:	During the meeting, there were present senior representatives from the following organisations: *The Department of National Education (DNE);* *The Science Advisory Council (SAC);* *The Agricultural Research Council (ARC);* *The Council for Scientific and Industrial Research (CSIR);* *The Foundation for Research Development (FRD);* *The Human Sciences Research Council (HSRC);* *The Medical Research Council (MRC);* *The Council for Mineral Technology (MINTEK);* *The South African Bureau of Standards (SABS);* *The Department of the Environment (D ENV);* *The Atomic Energy Commission (AEC);* *ESKOM;* *The Development Bank of South Africa (DBSA);* *The Royal Society of South Africa (Royal Society);* *The Association of Science and Technology Societies (AS&TS);* *The South African Chamber of Business (SACOB); and* *The Committee of University Principals (CUP).* In addition, there were present a number of interested individuals from universities and from the private sector.
Representatives of the Sponsors:	**The African National Congress**

Format of the Meeting:

After an introductory statement introducing the members of the Mission, the Meeting consisted, first, of a lengthy general discussion of the Mission's report, Towards a Science and Technology Policy for a Democratic South Africa, and, second, of briefer discussion on some of the sets of questions raised in the paper entitled Issues for Discussion.

The Morning Session

DNE

While the department publicly welcomed the report, and in particular the open discussion which it was designed to facilitate, it wished to comment on some particular issues:

- Description and assessment are often not distinguished in the report. Could less rhetorical language not be used? For example, one person's vacuum may be another person's devolution, and one person's fragmentation may be another person's decentralisation;

- Regarding the reference to a policy vacuum and its alleged consequences in the form of frozen resource allocations - this is a point where immediate work can be done to introduce goals such as affirmative action. A more thorough discussion of the formula approach would have been useful for the bureaucracy, as would guide-lines on what proportion of GNP should go to R&D, given the pressure on resources arising from other urgent needs;

- Also needing discussion is the question of government R&D and how extensive it should be compared with the scientific councils, universities and the private sector; and

- Fragmentation - the fact that the report can individually address and discuss the scientific councils may be regarded as a benefit of Framework Autonomy.

SAC A fundamental feature of the system in the universities and scientific councils is Framework Autonomy. How does the Mission view this? It would be a pity if this is thrown out in the course of radical change.

The Mission The report acts as a mirror to the South African S&T system, and so words such as "fragmentation" and "policy vacuum" were those used by officials in discussion with the Mission. Framework Autonomy is not as unique to South Africa as is sometimes thought. There is a widespread pattern, in many countries, of moving decision-making out of the civil service per se and into more autonomous bodies. The Mission's criticism of the policy concerns the way in which baseline funding has been constrained to depend on a frozen formula. The Mission thinks it is useful to delegate authority and decision-making, although there are still areas where more discretion is needed.

Royal Society Even given the brevity of the report, the absence of any mention of the role of a National Academy is a serious gap, and in particular the absence of any reference to the establishment of the National Academy of Sciences as a potential vehicle for science policy, independent of government, and for bringing together all parts of society within the system.

SAC Not enough is said on the constitutional aspect and of where science policy structures should be located.

CSIR The report also fails to place any focus on the technological process and functioning of the DTI - there is not much more than an oblique reference to the separation of science policy and technology policy. We should not neglect to look at the DTI.

CUP South Africa will sink or swim depending on its capacity to acquire foreign S&T - to fuel the Keynesian boom around housing and an export drive. We need to locate responsibility for S&T acquisition within Foreign Affairs and Trade - and to do this we need to get black people into S&T.

The Mission

The Mission did not meet with national societies, such as the Royal Society, but rather with the AS&TS, and it has commented on the role which such societies can play in creating informed public debate.

We did not make any recommendations regarding the place of S&T Policy structures within a future constitutional dispensation for two reasons:

- first, the Mission cannot predict the outcome of the constitutional negotiations which are about to resume; and
- second, there are a variety of models from which to chose, and it will be up to the head of a new government to decide on which form meets South Africa's needs.

The Mission visited the DTI and met with an official who had been in his present post for only two weeks; as a result, little understanding of the department's policy with respect to technology was obtained. We did register our surprise at the small amount of government funding for private sector R&D, and at the fact that the flow of funding goes from the private sector to government rather than the other way, which is the case in every other country in the world.

On combining Foreign Affairs with an S&T acquisition function - this can be done, but Canada has been less successful in this than Australia. The issue of structure is of less importance than the relation of the S&T function to effective political power and to the central executive function.

The Chair

It is important that the head of any government is an active supporter of national S&T activities - this is more important than the design of any particular organisational system. In France, for example, the organisational structure has not undergone significant change for many years, but S&T prospered under two Presidents who were committed to ensuring that France's capacities in S&T were harnessed to the national good. The same system went into relative

decline under presidents who showed little interest (Pompidou and Mitterand).

FRD — It must be understood that the small number of black people in the system is a consequence of the majority having been locked out of the system - those deliberating here today are not the best people to make representative decisions - black people are reluctant to entrust the present authorities with decisions about the future.

CSIR — This process has been under the patronage of the Democratic Movement, and we will soon have a democratically elected government. Each political party has the opportunity to develop policy on the issues raised by the report. What do we do next? The report provides a unique opportunity to move on and put something within the general domain which could help heal the rifts. To keep it within the framework of a political party would be to lose an opportunity. Ownership of the process needs to be shared.

AS&TS — AS&TS is undergoing an internal policy development process - and it is getting ready to make an input into the debate via a discussion document. We strongly support the idea of a debate.

DNE — I strongly support the idea of a debate, and relate it to the composition of the SAC. The SAC suffers from an absence of a voice of those involved in science. One can go two ways - the wise-men model or an interest- and constituency-based body.

The Chair — (responding to various points)

- With reference to Dr Mokhele's point about the lack of trust felt by the black population for government, there are examples worth examining. When the post-war British Labour government nationalised major industries, it had to put in charge the same people who had run the private enterprises. This worked well when the government gave clear guide-lines - the absence of such guide-lines is what is meant by a policy vacuum.

- With reference to the question of a national scientific academy - there are some advantages in having such a body of snobbish and gerontocratic people.

- Given the squeeze on resources which will be felt by a democratic government, the advisory and decision-making processes must carry authority and legitimacy.

CSIR Can you say more on guide-lines and the different styles in which they can be expressed, and what is the best style for such guide-lines if they are to create a sense of challenge to the creativity of scientists and researchers?

The Chair Among the points which a government will need to attend to in setting guide-lines with respect to S&T, I would include:

- the need to arrive at a balance between affirmative action and the excellence needed to maintain the respect of the scientific community in the country and internationally; and

- the need to maintain a balance of effort between South Africa's traditional exports - agriculture and mining - versus manufacturing.

The Mission The idea of "technology mission", discussed in the Mission's report, would contribute to the establishment of guide-lines, by setting out some specific goals and objectives.

SACOB We must bring to an end the intense competition for scarce resources in the tertiary education sector.

CUP We need collaboration within the tertiary system which is both voluntary and directed - but not autocratic. There is a strong possibility that we will see universities in particular regions moving towards federating over the next 10-15 years.

University representative

Universities do come together and have open discussions on the issues raised here - this is not reflected in the report.

The Mission

The Caribbean example illustrates one way to tackle the issue of cooperation/rationalisation in tertiary education. Despite the fact that there are now a large number of small independent states in that region, there is a single University of the West Indies which maintains several campuses throughout the region and which makes some decisions centrally while delegating others to the constituent campuses.

MRC

The task is to find a way of reallocating resources towards social goals, and away from "man-on-the-moon" and heart transplant technology.

The Mission

Some countries, such as Canada, have used directed programmes for funding networks of universities as an effective means of encouraging university research to move in the direction of economic and social goals. The control of funding is an important vehicle of influence over the directions of research.

Exercising public control over research in a sensitive and responsible manner involves setting guide-lines which reflect public purposes, and of a search for collaboration rather than direction. There are many ways such direction can be implemented: for example, inviting tenders within a framework, while specifying modes of collaboration between researchers and institutions, or modes of consultation with users, etc. can be a means of "encouraging" certain kinds of organisational behaviour. In a similar way a number of social, political and economic goals can also be combined in single projects. Establishing the rules for financing creates the biggest single point of pressure on the research system and avoids inappropriate attempts to dictate specific research projects to researchers. The goal is to harness the creativity of the research community to public purposes.

SACOB

Picking up some points relevant to the short term: SACOB has told DTI that it would not favour a council of wise men behind closed doors, but rather a technology forum working within broad economic guide-lines - might this meeting recommend broadening the subcommittee of the National Economic Forum to bring in other players in the S&T world?

In any case, an industrial strategy must be the basis of any technology mission, or preferably become the focus of government attention on technology development.

CSIR

Returning to the question of ministerial authority, the report implies two generic models: either a Ministry of S&T or an advisory structure linked to the chief executive function.

FRD

There is a case for having a Ministry of S&T in the first democratic government, regardless of some of the disadvantages, as a way of giving the issue of S&T a visible political profile.

University representative

A single voice for S&T in a future cabinet would be important in South Africa's situation.

The Mission

It is important to distinguish between the case for having a minister responsible for ensuring a governmental commitment to the development and use of S&T within a given country and the different case which may be made for creating a ministry with executive or policy responsibility for S&T.

The Mission made no specific recommendations on S&T Policy structures because of vast array of questions to be looked at. Arguments on the subject of a Ministry of S&T are evenly balanced. South Africans will have to analyse the situation of the country very clearly. It is crucial that the government believes that S&T is not a cost but one of the most important means to use available resources to achieve its goals. S&T is the basis of every area of human activity - it affects every facet of life and, at governmental level, it is important for the

implementation of the responsibilities of every department and agency.

The Mission was encouraged by the Democratic Movement's commitment to support S&T and to become active in a public debate on policy options.

The Chair — Given a number of remarks made by participants, then - if only for limited time - a minister for S&T may be of use. However, whether or not a minister is designated, the key is the extent to which a government is forward-looking in its decision-making.

CSIR — The message you are giving is that one should break away from an 'organogram approach' to government structures, and adopt a sophisticated approach to the use of management resources and techniques.

SAC — What experience is there in transforming military R&D capacity into civilian products? High expenditure on R&D in the military sphere has been cut, but without compensating increases elsewhere in the research system. The funds seem to have been lost to R&D.

The Mission — There is little detailed advice which the Mission can give here, other than to underline that transforming a military capacity into a civilian one has been shown, in countries such as the US which are now trying to do the conversion, to be a very difficult area in which to achieve success.

MRC — Much of the discussion has focused on the industrialised countries. What experience is there of successful application of R&D in developing countries?

Unidentified participant — There are excellent scientists and research institutions here in South Africa. We should build on that.

University Representative — In Zimbabwe there is a successful example - the Mopani centre - not of an S&T institution but of a body which is delivering a S&T approach to practical problems of a developing society.

The Mission In the developing world there are good examples of combining social science enquiry with first-class research in the natural sciences in order to attack the problems of poor populations. Many of the best examples come from agricultural research geared to the needs of subsistence farmers. For example, work in Sri Lanka developed fast-maturing varieties of rice which allow a third annual crop as an alternative to high-yielding varieties which required chemical inputs (fertilisers, pesticides). These inputs were far too expensive for small farmers in a country with no effective system of agricultural credit.

Afternoon Session

Royal Society Concerning the governance of the research institutions, how could one work out specific, and concrete criteria for membership of boards, defined for example with respect to interests to be represented?

SACOB The absence of material in the report on small and medium-sized enterprises is a serious gap, given the critical importance of job-creation programmes.

The Mission This gap reflects the gap we found in what we heard - we heard nothing to indicate that the needs of the SMEs were being addressed.

SACOB SACOB did not present information on this topic as it was not included in the questions posed by the Mission. Having said that, SACOB is in fact oriented towards large-scale rather than medium or small enterprises.

The Chair The meeting was invited to address the issues of decision-making and resource allocation set out in the paper "Issues for Discussion".

FRD With respect to priority-setting, a more unified agency function (for the provision of funding for research in the tertiary education system) would facilitate this and provide a lever.

SACOB

Part V of the National Peace Accord concerns a commitment to socio-economic reconstruction. A structure is being established which provides feedback on needs on the ground. Although it is limited by the (geographic) areas in which it is established, this provides a mechanism for interpreting and articulating needs.

CSIR

One mechanism for allocating resources to meet majority needs is via a client-contract relationship with particular communities. Has the Mission anything to say on how to ensure that the communities with needs for research have the resources to do so? How does one create buying capacity either in micro-enterprises or among rural peasants?

The Mission

This is a crucial question - how can society act in order to turn felt needs into effective demand. There is a strong role for organisations - such as NGOs - to assist people in articulating their needs. Beyond that, it is not easy to give examples. One general mechanism is for funders not to release finance until communities approve of work to be done for them. Another is to require "willing partners" to make joint proposals for funding.

In looking at the question of community involvement in research, one doesn't always need to involve each and every community in research - successful work can be replicated in similar circumstances. The question of the diffusion of successful research is a key dimension. India has undertaken the process of franchising technologies with the objective of massive dissemination.

DNE

The answer to CSIR's question about the buying capacity of poorer communities is: that is what the parliamentary grant is for.

SAC

Returning to the question of S&T Policy mechanisms, the SAC's term of office expires in 1994, by then we will have an interim government. Thought is being give to its future and its role.

AEC — It was interesting to note in the report that the SAC was unsure of whether it should take in technology - is this being included in the review of its role?

SAC — We await the national economic plan in order to decide on this issue.

CUP — The report says that the SAC is inappropriately located in the DNE - do you agree?

SAC — The expertise required does not reside in the DNE, which merely provides a secretariat. The present inherited situation is being reviewed. But there are great benefits to working together with the DNE.

The Mission — An important consideration is that a body with the task of advising on the overall functioning of government should not report to a minister with a single, sectoral, function like the DNE. There have been a number of references to the nature of the advice which an advisory body should render - whether it should be confidential or not. While a case can be made for some of the advice to government being confidential, by and large, the Mission favours a much more open advisory system than the one now in place in South Africa.

CSIR — The notion of the "Republic of Science" is potentially dangerous for science policy - could you comment on this.

The Mission — We found signs of this approach in the South African system. It is one we reject. Decisions on resource allocation for scientific activities are political and must be informed by the goals of government.

CSIR — I fully endorse that view - but it differs radically from the words in the report on this topic. [While the report did take the stance reported by the Mission, the wording used has been slightly edited in the final version to ensure greater clarity in the manner in which the opinion is expressed. Ed.]

SAC — The SAC is looking at ways to earmark some agency funds for specific resource allocations. What experience

is there in this direction? Currently, money going into baseline funding of councils or universities is undirected.

The Chair — If you do this you must have very specific output criteria. A (small) part of the resources can be reserved for "Republic of Science" activities, even though most of the resources for science are for social purposes.

SAC — We have a tendency to get hung up on structures. If we focus on our goals then perhaps we would gain a better perspective on structures.

HSRC — Have we had enough discussion on the problems of the majority? There are particular impediments to dealing with the problems of the majority - particularly as these problems don't lie within the spheres of interest or achievement of scientists, who structure their work in terms of global developments.

I believe that we know what we would like to fund and what communities could successfully direct. But we don't find the response amongst the community of scientists - they are guided by powerful and ongoing achievements within their disciplines and institutions.

DBSA — There are institutional requirements for meeting the needs of the majority which lie beyond the role of the SAC and the provision of funding mechanisms.

Priorities for South Africa are, first, jobs and money, and second, housing, water, sanitation etc. We need less science than technology. The real source of sustainable development will come from the private sector not the public sector. We must look at policy that asks business: "Does your organisation obstruct small enterprise?"

Final Session

At the opening of the final session, the Chair invited input from any organisation with specific points of correction to the report.

AEC

The report only reflects the situation, for our organisation, as it was 4-5 years ago - it is a pity that the information on restructuring we gave the Mission is not reflected in the report. The AEC has been too great a drain on resources, and we need support to redirect it towards non-nuclear work. We have already made some progress in this regard.

The Mission cites a report which suggests that South Africa has a nuclear weapons programme - this was rejected by the UN. The accusation is a serious one.

CSIR

Lets talk about the way forward!

FRD

The FRD is fully responsible for the National Accelerator Centre and is not simply a post-box for its budget, as indicated in the report.

CUP

The Mission's treatment of the National Accelerator Centre was superficial.

CSIR

The Mission's conclusion that closing the NAC and reallocation of its budget would be acceptable to the vast majority of South African Scientists is clearly a reflection of the present reality.

MRC

A large portion of the MRC's activities goes into technology transfer. The MRC works extensively with NGO's and other grassroots organisations. The mission may have misunderstood the nature of various MRC units.

HSRC

The allegations that the HSRC has worked with the government may be true. However the report does not reflect that the HSRC has done a great deal of positive work as well: for instance, the HSRC's work in the early 1980s against the death penalty. Only 13% of the HSRC's work is for the government, and all work for the government is contract research. We would like funders and NGO's to suggest research areas which the HSRC could undertake. The HSRC does fund an in-house apprenticeship programme and has established research capacities at the HBUs. We find ourselves in a Catch-22 situation that is not helped by the Mission's report.

CSIR — I would like to focus on the education crisis. We will have to actively intervene in the universities if they do not change. People are being trained in the area of S&T without any recognition of international changes in S&T.

PROTEC — I would like to see the statutory councils speak to their vision of the future for South Africa.

MRC — The Mission's report missed out on crucial elements. Many of the universities are currently undergoing change but the report gave no sense of that change.

AS&TS — Change is indeed happening at the universities.

The Mission — The mission appreciates the scope of the change occurring in the universities. However, there are still significant differences between the perceptions of the need for further change in the tertiary system - as put forward at yesterday's meeting with the Democratic Movement - as compared to the interventions at this meeting. Ultimately, all the Mission can do is hope to provoke questions.

Concluding Session

The Chair — Enormous resources will be required to enact change in South Africa. Thus the economy is critical to that change, and S&T must be aligned to support the economy. However, pure research is also important.

The present initiative has brought people together who would not normally have met. The process, in this case, is the key. As an outsider, I was disappointed to discover that it required this unusual step in order to initiate the process.

MRC — It is important not to ask what is wrong with the statutory councils but to ask "What are our goals?". Once we can answer that, the structures will fall into place.

CSIR The chair should not underestimate the power of this process. We are here at the invitation of the Democratic Movement. My greatest fear is that the Democratic Movement may carry the process forward in an exclusive manner. I am asking the Democratic Movement to include us in that process.

FRD The FRD echoes the request. We hope the Democratic Movement will include us in the process.

DNE I must reserve judgement whether my department supports the previous remarks by CSIR and FRD. I must consult with my superiors first.

DBSA We already have an economic forum. Thus, we have a structure under which an S&T forum could be constructed.

HSRC Congratulations to the ANC/COSATU/SANCO on the first critical review of S&T Policy. I support CSIR's remarks regarding the process being inclusive. What will happen to the report now?

DBSA It is not altogether helpful for one side to ask for an inclusive process while it carries on with its own exclusive processes.

MRC There should be no unilateral restructuring until consultation has taken place. There should be a freeze on high-level hiring.

DNE Consultation is acceptable but not necessarily in public. It is impossible for us to do nothing. I propose that we liaise directly with the Democratic Movement, carry on with consultation, but in the spirit of carrying on with our daily work.

ESKOM It is a pity that large industry was not consulted more in this process.

ANC I am surprised, and encouraged, to see a debate on how to impress on a new government the importance of S&T. We must mobilise S&T to achieve our broad

goals. S&T must permeate every programme of government.

A major question ahead is "How do we organise structures to achieve our goals?" S&T Policy must include the human sciences - technology is not, and should not be seen as, an end in itself.

How do we shift away from a S&T Policy that served apartheid? None of us who have lived through apartheid and its effects can simply deny our share of responsibility for the past.

For the majority of the population, the statutory councils are not seen as "national" bodies, even though they are financed with tax payers' money.

We in the Democratic Movement are not prepared simply to be consulted as clients of the statutory councils; we must be involved in formulating policy in a new South Africa. How can we address the needs of the masses? A starting point is to ensure that the highest structures are representative of the majority.

The problem is not that blacks are incapable of articulating their needs, but that whites haven't been prepared to listen. If the charge that the system today is unrepresentative is not true, then why are the only two white women in the room today from the press?

I would like to make these two points:

1. affirmative action is the key; and

2. this debate must be honest and open.

Following this meeting, the Democratic Movement will be setting up a task force to take this process forward. I can assure you that it will be an inclusive process.

Appendix 5:

Issues for Discussion

Decision Making and Resource Allocation

The report by the mission on Science and Technology for a Democratic South Africa identifies a current vacuum at the highest level of government. A new administration will have to address the following set of issues:

- Assigning appropriate ministerial authority to ensure both that there is a clear focus of high-level responsibility for decision-making on S&T, and that there are viable functioning systems to ensure that S&T Policy is fully integrated with other principal policy directions of that government. Such an integration will need a two-way flow of information and ideas, into and out of the S&T system.
- Structuring the resource allocation for S&T in ways which recognise the overall restraints on the government's financial position and the need to bring about important reallocations within the portfolio of S&T activities.
- In the short to medium term, reconstructing the governing boards of the major government S&T institutes is the best way to make them both reflect the population to be served by the institution, and competent overseers of those institutions; what steps need to be taken now to prepare for these changes?
- In a government committed to consultation, what are the appropriate kinds of mechanisms for consultation and for obtaining general advice and advice aimed at individual institutions, including ministries, statutory councils and so forth?
- What kinds of programmes are needed within S&T institutions to ensure that the management of those bodies comes to reflect the make-up of the South African population as speedily as possible?

Focusing on the Problems of the Majority

Throughout the South African S&T system, in all sectors, but particularly within government, overwhelming attention has been paid to the problems of the white, more affluent, population. A new government will wish to bring about significant reorientation of many programmes, particularly to ensure that the "basic human needs" of the majority of the population are met as rapidly as is physically and financially possible.

- What capacity does the South African S&T system have to respond to such an important change of direction?
- Can the existing government institutions change their patterns of operation sufficiently to allow them to engage in meaningful cooperation with disadvantaged populations? To what extent are the changes presently being introduced into the statutory councils in the right direction? Are they adequate in concept or content?
- What roles can popular South African NGO's play as bridges between the community and the research system?
- How can the social sciences and the natural and engineering sciences be brought together to look at the introduction of technology into the lives of South Africans in a systematic way?
- How can communities be empowered to exercise some influence or control over resource allocations to activities designed to alter their lives?
- Are the institutions of higher learning - especially the universities and technikons - able to train researchers with the skills needed to promote technical change in disadvantaged communities? Do those institutions themselves also need to examine their modus operandi?

The S&T Roles of Higher Education

South Africa faces enormous challenges throughout its educational system, and particularly in the way black students are treated. The process of change needs to be sweeping, and will take many years to be fully achieved. This long period of change creates the necessity for significant programmes to upgrade the skills of those who have already passed through the system, or who are far enough through to have received inferior education.

In the higher education system, the mission is concerned with both the role of the research institutions and their role in the training of new participants in the S&T system - researchers, engineers, managers, technicians, and entrepreneurs.

- How can the system of higher education as a whole be reformed, to eradicate the racially-based inequities of the past?
- With respect to research, what changes in the financing system are required to produce a rational system which creates a sound and equitable set of opportunities to faculty members to contribute to national economic, social and cultural development?
- What specific kinds of remedial programmes, for individuals and for institutions are needed to begin the long task of rectifying the injustices of the past? What share of available resources must be allocated to this purpose?
- Does the mission's proposal for the creation of an Independent Commission of Enquiry into Tertiary Education by the Democratic Movement, seem a worthwhile initiative? If it is, how could it be launched?

Science, Technology and International Competitiveness

Much global attention is now focused on the role of S&T in promoting international competitiveness of firms and by extension of national economies. In a post-sanctions era, South Africa will come under pressure to reduce the levels of protection it has traditionally afforded to domestic enterprises. South African enterprises' export performance will also become an important source of economic growth and employment. Against this backdrop:

- What kind of policies should be pursued to improve the technological performance of South African industries?
- How can companies be induced to invest more in enhancing their own technological performance?
- What responsibilities will the state assume for helping small and medium scale enterprises to upgrade their technological capacities?
- What roles could be foreseen for government and university research groups in assisting industry? What current barriers need to be overcome?
- Does South Africa have the capacity to compete in the application of some of the new and emerging fields of "high-technology"?
- Can South Africa' s need to meet the basic needs of the majority of its population be seen as a key element in an industrial strategy which includes a strong focus on job creation? If this is so, who will take care of the S&T dimensions of this strategy?
- What would constitute the strategy of a future South Africa vis-à-vis the importation of technology? Is an import-control system a useful policy tool, given the objectives of a new government?
- How can South African industry play a significant role in upgrading the technological capacity of the nation's work-force?

Links to the International S&T Community

When a new government takes power, South Africa will need to assess the way in which it resumes playing an appropriate role in the international S&T community. This will see it reinstating traditional ties to the industrialised countries, opening new relationships within the Third World, with relations with neighbouring African States being particularly important, and creating governmental relations with international donor agencies, both multi and bilateral.

- What policy objectives will South Africa set for itself, against what kind of time-frame? And what kind of resources will it deploy in support of its goals?
- In relation to its negotiations with donor agencies, what priority will a new government allocate to S&T and to resolving the problems of human resource development for a more technological future? In the particular case of agriculture, will a special effort be made to tap international experience in dealing with the problems of small farmers and rural communities?
- Will the direct support received, in recent years from donor agencies - by researchers allied to the Democratic Movement (primarily in the social sciences) - dry up once those donors see a legitimate, democratic government in place?
- Should South Africa seek to engage in some regional S&T initiatives with its neighbours to the north? If so, in which fields would such initiatives be most useful for all of the parties concerned?
- What role will South Africa seek to play in international programmes of basic research? How much can it afford?

Where to Begin

When a new government takes office, it will be under tremendous pressure from all quarters to take speedy and effective action on everything. Selecting priorities will be extremely difficult as attempts are made to balance legitimate but competing claims on limited state resources.

How many actions can be initiated in advance of a new government being sworn into office? Are the policy consultations which are intended to follow release of the Mission's Report structured in a way to promote wide participation from all segments of society?

- How much change can, or should, be initiated at this time?
- What preparations should be undertaken by the Democratic Movement in advance of the installation of a new government?

Notes and Sources

[1]Economic Commission for Latin America and the Caribbean, (ECLAC), *Social Equity and Changing Production Patterns: an Integrated Approach*, (ECLAC Document No LC/L.668) Santiago, Chile, January 1992.

[2]For a more detailed discussion, see Mytelka, *op cit.*

[3]OECD, "Technology and the process of Internationalisation Globalisation", Draft Background Report, Technology/Economy Programme, 17 September 1990.

[4]See *Technology and the Economy*, OECD Paris 1992, p19.

[5]Michael Polanyi, "The Republic of Science: its Political and Economic Theory", *Minerva*, Vol 1, No 1, Autumn 1962.

[6]See Department of National Education, *The Science Policy And System of the Republic of South Africa*, NATED 11-005 (88/06), June 1988.

[7]See Department of National Education, *A System of Framework Autonomy for Scientific Councils*, NATED 11-007 (88/04), April 1988.

[8]Data for CSIR and HSRC are from tables provided to the Mission by those councils; other data are derived from Annual Reports.

[9]These are set out in Section 2 of NATED 11-007.

[10]Taken from A. Pouris, *A Funding Approach for Incorporating Priorities in the Allocation of Funds to Scientific Councils*, prepared for the Department of National Education by the Centre for Evaluation and Policy of the FRD, May 1992.

[11]See CSIR Policy Studies No 1, *Science and Technology Policies and Economic Development: a Review of International Experience*, Scientia Publishers, Pretoria, 1991.

[12]See CSIR, *Leadership 1991: Strategic Management Review*, Pretoria, September 1991.

[13]See Lord Rothschild, "An enquiry into the Social Science Research Council" Cmmd 8554, London, HMSO, 1989 and cited, *in extenso*, in A. Pouris, *op cit.*

[14]The budget figures for these FRD-managed activities include not only parliamentary grants but also funds brought forward from previous years, contributions from partners in joint programs, sales of isotopes and user fees from Uninet. The relevant figures for the separate parliamentary grants are:

FRD	R57.06-m
NAC	R28.80-m
SAAO	R4.90-m
Hart RAO	R2.40-m
International Liaison	R2.30-m

[15]See Henry J. Kaiser Family Foundation, *Changing Health in South Africa: Towards New Perspectives in Research*, November 1991.

[16]See MRC, *Annual Report for 1991*, p3.

[17]As defined in the Commission on Health Research for Development, *Health Research: Essential Link to Equity and Development*, Oxford University Press, 1990.

[18]See W.M. Pick and G.N. Padayachee "Community Health Research: Some Challenges", *CHASA Journal.*

[19]See for example Mintek, Application report No 3, *The development of an integrated carbon-in-pulp process for South African conditions*, 1987.

[20]SABS, *Annual Report for 1991*, p5.

[21]See for example SABS, *Product and System Specification: Europe 1992*, September 1991.

[22]See F.A. Sonn, "The Role and the Place of the Technikons", Address to a NUMSA seminar, Johannesburg, August 1992, p9.

[23]However, even in using this data, we are aware that there is no good source of comprehensive data available on the support from foreign donors, which has been increasing in recent years.

[24]Department of National Education, *Results of Survey Program* No 16, NATED 11-010 (91/07), Table 2.3, pp54-56

[25]NATED 11-010, *op cit.*

[26]See, for example, policy statements by the Committee of Technikon Principals on "A Research Philosophy for Technikon Education" (January 1989), on "Career Education and Technology" (1991), on "Technikon Qualification Structure" (March 1992), or on "The Place and Role of Technikons" (also in 1992). The Mission found no comparable evidence of output from the Committee of University Principals.

[27]Source: *"Education realities in S.A. 1990"*, p49, cited in F.A. Sonn, *op cit.*

[28]A useful summary and introduction to international experience is to be found in A.S. Bhalla, ed, *Small and Medium Enterprises: Technology Policies and Options*, Greenwood Press, 1991.

[29]See for example, OECD, *The Literate Worker*, Paris, 1991, or D. Hirsch, "Overcoming Adult Illiteracy", *OECD Observer* 171, 1991, p23.

[30]*Draft Report, Agricultural Sector Mission*, World Bank, April 1992.

[31]A. Pouris, *op cit.*

[32]Department of National Education, *Resources for R&D 1989/90; Results from Survey programme No 16*, Doc NATED 11-010 (91/07). Data are from Table 2.9.

[33]Dept of Environmental Affairs,"Research Projects Supported by the Dept. of Env. Affairs, 1992/93", Mimeo.

[34]Taken from UN Document A/CONF.151/5/Rev.1 of 13 June 1992.

[35]SAVI, "Technological Human Resources for Industry Programme (THIRP): Business Plan-April 1992", (typescript).

[36]A good example is the Nairobi-based African Economics Research Consortium, a not-for-profit entity which enjoys close relations with government policy makers and which is financed by a carefully constructed consortium.

[37]*Nuclear Fuel*, October 1992.

[38]B.R. Martin and Irvine John, *Research Foresight: Priority Setting in Science*, Pinter Publishers, 1989.

[39]For a much more detailed discussion of Technology Missions, see The United Nations Advisory Committee on S&T for Development, Report of the Panel of Experts on Technology Missions, UN Document A/CN.11/AC.1/XI/2 of December 1990.